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First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 15–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26–27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Louis, Mo., Dec. 31, 1919–Jan. 2, 1920. President, W. C. O'Kane; First Vice-President, A. G. Ruggles; Second Vice-President, H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

Thirty-third Annual Meeting, Chicago, Ill., Dec. 29–31, 1920. President, Wilmon Newell; First Vice-President, H. A. Gossard; Second Vice-President, E. M. Ehrhorn; Third Vice-President, J. G. Sanders; Fourth Vice-President, F. B. Paddock, Secretary, A. F. Burgess.

Thirty-fourth Annual Meeting, Toronto, Canada, Dec. 29–31, 1921. President, George A. Dean; First Vice-President, Arthur Gibson; Second Vice-President, E. O. Essig; Third Vice-President, A. G. Ruggles; Fourth Vice-President, H. F. Wilson; Secretary, A. F. Burgess.

Thirty-fifth Annual Meeting, Boston, Mass., Dec. 28–30, 1922. President, J. G. Sanders; First Vice-President, J. M. Swaine; Second Vice-President, A. L. Lovett; Third Vice-President, R. W. Harned; Fourth Vice-President, M. C. Tanquary; Secretary, A. F. Burgess.

Thirty-sixth Annual Meeting, Cincinnati, Ohio, Dec. 29, 1923–Jan. 2, 1924. President, A. G. Ruggles; First Vice-President, H. A. Gossard; Second Vice-President, H. J. Quayle; Third Vice-President, P. A. Glenn; Fourth Vice-President, S. B. Fracker; Secretary, A. F. Burgess.

Thirty-seventh Annual Meeting, Washington, D. C., December 31, 1924–January 3, 1925. President, A. F. Burgess; First Vice-President, M. C. Tanquary; Second

Vice-President, H. S. Smith; Third Vice-President, E. R. Sasscer; Fourth Vice-President, R. W. Harned; Secretary, C. W. Collins.

Thirty-eighth Annual Meeting, Kansas City, Mo., December 29, 1925–January 1, 1926. President, H. A. Gossard (died in office December 18, 1925); First Vice-President, R. N. Chapman (assumed duties of President for remainder of term); Second Vice-President, Leroy Childs; Third Vice-President, C. H. Hadley; Fourth Vice-President, R. L. Webster; Secretary, C. W. Collins.

Thirty-ninth Annual Meeting, Philadelphia, Pa., December 28, 1926–January 1, 1927. President, Arthur Gibson; First Vice-President, C. J. Drake; Second Vice-President, W. B. Herms; Third Vice-President, L. A. Strong; Fourth Vice-President, J. I. Hambleton; Fifth Vice-President, W. E. Hinds; Secretary, C. W. Collins.

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Proceedings of the Thirty-Ninth Annual Meeting of the American Association of Economic Entomologists

The thirty-ninth annual meeting of the American Association of Economic Entomologists was held in Logan Hall, University of Pennsylvania, Philadelphia, Pa., December 28, 1926 to January 1, 1927.

The Section of Plant Quarantine and Inspection convened at 10 a. m., Dec. 28 and continued through that day. In the absence of Chairman L. A. Strong, C. H. Hadley of Harrisburg, Pa. was elected Chairman pro tem. Dr. C. L. Marlatt, Chairman of the Federal Horticultural Board, spoke on the "Effect of the Supreme Court Decision of March 1, 1926, in the Case of the Oregon-Washington Railroad and Navigation Company vs. the State of Washington on the Basic Quarantine Laws of the Various States." The above subject was opened by Dr. Marlatt and continued as a round-table discussion by the various members. Several other very interesting papers were presented, among these being two papers on "Inspection of Vehicular Traffic in the Enforcement of Plant Quarantines" with reference to the Japanese Beetle and the European Corn Borer.

The Section of Apiculture held an interesting session Wednesday afternoon, December 29, and was continued in the evening; 11 interesting papers were listed on the program for this Section and two demonstrations which aroused considerable interest, namely: "The Five Year Brood Record of a Single Queen" by W. J. Nolan; "Waxworm Fumigation Experiments" by F. B. Paddock; "Federal Honey Grading Rules" by E. L. Sechrist and "The Fertilization and Hibernation of Queen Bumblebees under Controlled Conditions" by T. H. Frison, were of special interest. The Chairman gave an interesting paper on "Certain Phases of Apicultural Research in the United States" which was well received. An interesting paper was given during the evening by Dr. E. F. Phillips, Ithaca, N. Y., entitled: "Some Things I Heard and Saw while Visiting Bee Keepers and Their Societies in Europe in Summer of 1926."

The observations by Dr. Phillips were most interesting. Two features of the program of this Section were demonstrations on the artificial insemination of queen bees by Mr. Lloyd R. Watson and on "The Relative Sensitivity of Honey Bees to Light of Different Wave Lengths" by Lloyd M. Bertholf. The demonstrations made were very striking.

Two interesting conferences were held—one on Wednesday afternoon on arsenical residues on fruit, which was well attended and lively discussions on orchard sprays and the residues remaining on fruit under general orchard practice schedules of spraying; and one on oil sprays held Thursday afternoon. This was also well attended and considerable interest taken in the discussions that followed.

The Crop Protection Institute held its annual dinner and business meeting on Tuesday evening, December 28.

The program of the main Association opened Wednesday morning with a business session. The afternoon and evening was devoted to the session of the Section of Apiculture. The main Association meeting was continued Thursday morning ending Saturday at 11:30 a. m. with the final business session. Reports of the various committees were read and action taken, this being followed by the address of the President entitled: "International Entomology—Retrospective and Prospective." Among the striking papers was one by E. O. Essig on "Some Highlights in the History of the Development of Entomology in California;" "Hot Water Bulb Sterilizers" by C. A. Weigel; "New Control Measures for the Squash Vine Borer" by C. R. Cleveland; "Biological Factors in the Control of the Celery Leaf-Tyer" by E. D. Ball and others; "Baits More Attractive to the Oriental Peach Moth than 'Black-strap' Molasses" by Alvah Peterson; "Experiments in Control of the Rose Chafer" by J. R. Eyer and others; "Arsenical Content of Sprayed Apples" by Albert Hartzell and others; "Cyanide Dust Fumigation" by H. J. Quayle and "Termites Modify Building Codes" by T. E. Snyder. Interesting papers were also presented on Airplane dusting for Gipsy Moth Control, Airplane Dusting for Control of Hemlock Spanworm and Airplane Dusting of Sugar Cane. An interesting group of papers was also presented on the various phases of the Japanese Beetle Control work including parasites, attraction, spraying and methods of treatment of soil.

On the night of December 30 the entomologists held a dinner in the roof garden of the Hotel Walton, which was attended by 231 members and guests. The details were planned by the members of the Japanese Beetle Laboratory and a very unique entertainment was put on. Dr. W. E. Britton acted as toastmaster and called upon several past presidents for remarks. Several parodies on some of the well-known popular

songs were composed which portrayed well the humorous side of some entomological investigational projects and men. The dinner was enjoyed by all, being considered one of the most successful ever held.

Some exhibits were opened in a room close to the meeting room, which contained exhibits of the Japanese Beetle laboratory work, airplane dusting in Wisconsin, some apparatus, etc, which was available during the period of the meeting. This exhibit was in co-operation with that of the Entomological Society of America.

The extension entomologists and Insect Pest Survey held a meeting Friday evening, December 31, which was attended by more than 50 members. A very interesting paper was presented by J. A. Hyslop on the Insect Pest Survey work, in which he ably set forth the needs for new and better methods of estimating and keeping records of outbreaks of insects and damage to crops.

The business proceedings form Part I of this report and the addresses, papers and discussions form Part II.

The proceedings of the Sections of Plant Quarantine and Inspection and Apiculture will also be included in Part II.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President Arthur Gibson at 9:50 a. m., Wednesday, December 29, 1926. About 300 members and visitors attended the sessions. The following members were present:

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Boyden, B. L., Tampa, Fla.
Britton, W. E., New Haven, Conn.
Brittain, W. H., Truro, N. S.
Broadbent, (Miss) B. M., Washington, D. C.
Bromley, S. W., Azusa, Calif.
Burgess, A. F., Melrose Highlands, Mass.
Buys, J. L., Canton, N. Y.
Campbell, R. E., Alhambra, Calif.
Cartwright, O. L., Columbia, S. C.
Caudell, A. N., Washington, D. C.
Claasen, P. W., Ithaca, N. Y.
Cleveland, C. R., Lafayette, Ind.
Collins, C. W., Melrose Highlands, Mass.
Cook, M. T., Bozeman, Mont.
Cory, E. N., College Park, Md.
Crosby, C. R., Ithaca, N. Y.
Cutright, C. R., Wooster, Ohio
Daniel, D. M., Geneva, N. Y.
Davis, J. J., Lafayette, Ind.
Dean, G. A., Manhattan, Kan.
De La Parelle, H. J., Atlanta, Ga.
De Long, D. M., Columbus, Ohio.
Dietz, H. F., Indianapolis, Ind.
Dills, L. E., Inwood, W. Va.
Doane, R. W., Stanford University, Calif.
Dohanian, S. M., Somerville, Mass.

Doucette, C. F., Santa Cruz, Calif.
Dozier, H. L., Newark, Del.
Drake, C. J., Ames, Iowa.
Drinnan, D. E., Knoxville, Tenn.
Dunavan, David, Ames, Iowa.
Dustan, A. G., Ottawa, Can.
Eddy, M. W., Carlisle, Pa.
English, L. L., Urbana, Ill.
Essig, E. O., Berkeley, Calif.
Ewing, H. E., Washington, D. C.
Eyer, J. R., North East, Pa.
Faxon, Richard, Columbus, Ohio.
Felt, E. P., Albany, N. Y.
Fenton, F. A., Florence, S. C.
Fernald, T. H., Amherst, Mass.
Filinger, G. A., Wooster, Ohio.
Fink, D. E., Philadelphia, Pa.
Fleming, W. E., Riverton, N. J.
Flint, W. P., Urbana, Ill.
Fox, Henry, Riverton, N. J.
Fracker, S. B., Madison, Wis.
Frison, T. H., Urbana, Ill.
Gambrell, F. L., Geneva, N. Y.
Garman, H., Lexington, Ky.
Garman, Philip, New Haven, Conn.
Garthside, S., Sydney, Australia.
Gibson, Arthur, Ottawa, Canada.
Ginsburg, G. M., New Brunswick, N. J.
Glasgow, Hugh, Geneva, N. Y.
Glenn, P. A., Urbana, Ill.
Goodwin, J. C., Gainesville, Fla.
Grady, H. J., Augusta, Kan.
Graf, J. E., Washington, D. C.
Granovsky, A. A., Madison, Wis.
Grant, Dudley H., New York, N. Y.
Griswold, Grace H. (Miss), Ithaca, N. Y.
Guyton, T. L., Harrisburg, Pa.
Haack, T. T., Toledo, Ohio.
Haber, V. R., State College, Pa.
Hadley, C. H., Harrisburg, Pa.
Haeussler, G. J., Palmyra, N. J.
Hallock, H. C., Riverton, N. J.
Hambleton, J. I., Washington, D. C.
Hamilton, C. C., New Brunswick, N. J.
Harman, S. W., Geneva, N. Y.
Harned, R. W., A. & M. College, Miss.
Hartzell, Albert, Yonkers, N. Y.
Headlee, T. J., New Brunswick, N. J.
Herrick, G. W., Ithaca, N. Y.
Hinds, W. E., Baton Rouge, La.
Hodgkiss, H. E., State College, Pa.
Holdaway, F. G., Adelaide, Australia.
Holloway, T. E., New Orleans, La.
Hooker, W. A., Washington, D. C.
Horsfall, J. L., New York, N. Y.
Hough, W. S., Winchester, Va.
Houser, J. S., Wooster, Ohio.
Howard, L. O., Washington, D. C.
Howard, N. F., Columbus, Ohio.
Huber, L. L., Wooster, Ohio.
Huckett, H. C., Calverton, N. Y.
Hungerford, H. B., Lawrence, Kan.
Hutson, Ray, New Brunswick, N. J.
Hyslop, J. A., Washington, D. C.
Johannsen, O. A., Ithaca, N. Y.
Johnson, J. Peter, Riverton, N. J.
Jones, M. P., Columbus, Ohio.
Kamal, Mohammed, Riverside, Calif.
Kelsheimer, E. G., Ames, Iowa.
Kennedy, C. H., Columbus, Ohio
King, J. L., Riverton, N. J.
Kirk, H. B., Harrisburg, Pa.
Kisliuk, Max, Philadelphia, Pa.
Knull, J. N., Harrisburg, Pa.
Larrimer, W. H., Washington, D. C.
Lathrop, F. H., Washington, D. C.
Leiby, R. W., Raleigh, N. C.
Leonard, M. D., Ithaca, N. Y.
Lipp, J. W., Riverton, N. J.
List, G. M., Fort Collins, Colo.
Lowry, P. R., Durham, N. H.
Manter, J. A., Storrs, Conn.
Marlatt, C. L., Washington, D. C.
Matheson, Robert, Ithaca, N. Y.
Mathewson, A. A., Meadville, Pa.
McIndoo, N. E., Washington, D. C.
McLaine, L. S., Ottawa, Can.
Merrill, G. B., Gainesville, Fla.
Mills, A. S., Ithaca, N. Y.
Montgomery, J. H., Gainesville, Fla.
Moore, William, New York, N. Y.
Morrill, A. W., Los Angeles, Calif.
Morrison, Harold, Washington, D. C.
Mosher, Miss Edna, Brooklyn, N. Y.
Nelson, F. C., New Brunswick, N. J.
Newell, Wilmon, Gainesville, Fla.
Nickels, C. B., Clemson College, S. C.
O'Kane, W. C., Durham, N. H.

Osborn, Herbert, Columbus, Ohio.
Osburn, R. C., Columbus, Ohio.
Osgood, W. A., Durham, N. H.
Packard, C. M., Sacramento, Calif.
Parks, T. H., Columbus, Ohio.
Parrott, P. J., Geneva, N. Y.
Patch, Edith M., (Miss), Orono, Me.
Patch, L. H., Sandusky, Ohio.
Peters, H. S., Columbus, Ohio.
Peterson, Alvah, Riverton, N. J.
Phillips, E. F., Ithaca, N. Y.
Phillips, W. J., Charlottesville, Va.
Poos, F. W., Sandusky, Ohio.
Popenoe, C. H., Washington, D. C.
Porter, B. A., Washington, D. C.
Primm, J. K., Chicago, Ill.
Quaintance, A. L., Washington, D. C.
Quayle, H. J., Riverside, Calif.
Rea, G. H., Reynoldsville, Pa.
Ries, D. T., Ithaca, N. Y.
Riley, W. A., St. Paul, Minn.
Robinson, J. M., Auburn, Ala.
Rohwer, S. A., Washington, D. C.
Rosenfeld, A. H., New Orleans, La.
Rosewall, O. W., Baton Rouge, La.
Ruggles, A. G., St. Paul, Minn.
Safro, V. I., Los Angeles, Calif.
Sanders, P. D., College Park, Md.
Sasscer, E. R., Washington, D. C.
Satterthwait, A. F., Webster Groves, Mo.
Scammell, H. B., Toms River, N. J.
Schoene, W. J., Blacksburg, Va.
Scott, L. M., Washington, D. C.
Siegler, E. H., Washington, D. C.
Sherman, Franklin, Clemson College, S. C.
Simmons, Perez, Silver Spring, Md.
Smith, F. F., Willow Grove, Pa.
Smith, L. B., Riverton, N. J.
Snyder, T. E., Washington, D. C.
Spencer, G. E., Woodbury, N. J.
Stafford, E. W., Agricultural College, Minn.
Stear, J. R., Chambersburg, Pa.
Stearns, L. A., New Brunswick, N. J.
Stewart, M. A., Ithaca, N. Y.
Stockwell, C. W., Riverton, N. J.
Sullivan, K. C., Columbia, Mo.
Swaine, J. M., Ottawa, Canada.
Thomas, C. A., Philadelphia, Pa.
Trimble, F. M., Camp Hill, Pa.
Underhill, G. W., Onley, Va.
Van Leeuwen, E. R., Riverton, N. J.
Vickery, R. A., Arlington, Mass.
Wade, J. S., Washington, D. C.
Wallace, F. N., Indianapolis, Ind.
Walter, E. V., Tempe, Ariz.
Watson, J. R., Gainesville, Fla.
Webber, R. T., Melrose Highlands, Mass.
Weed, Alfred, Madison, Wis.
Wehrle, L. P., Ithaca, N. Y.
Weigel, C. A., Washington, D. C.
Wheeler, C. M., Knoxville, Tenn.
White, W. H., College Park, Md.
Whitmarsh, R. D., Wooster, Ohio.
Wood, W. B., Washington, D. C.
Worthley, H. N., State College, Pa.
Worthley, L. H., Arlington, Mass.
Zappe, Max P., New Haven, Conn.

PRESIDENT ARTHUR GIBSON: Ladies and Gentlemen, and Members of the Association: It is my pleasure to call to order the thirty-ninth annual meeting of the American Association of Economic Entomologists.

We have a very large and long program ahead of us. I am going to ask all who are taking part to be brief in the presentation of their reports and to try to keep within the time limits when their papers are being presented.

The first item on the program this morning is the report of the Secretary.

REPORT OF THE SECRETARY

The membership of the Association at the time of the Kansas City meeting together with the election of new members, resignations, those dropped for non-payment of dues and losses by death since, is summarized as follows:

	Active	*Associate*	*Foreign*
Total membership, beginning of Kansas City meeting	374	390[1]	50
Transferred from Associate to Active membership, Kansas City meeting	+ 26	— 26	
	400	364	50
Members elected, Kansas City meeting		+ 78	
Re-instatements, Kansas City meeting		+ 4	
Resignations, Kansas City meeting		— 4	
Total membership, close of Kansas City meeting.	400	442	50
Dropped for non-payment of dues, 1926	— 5	— 32	
Deaths recorded since last meeting	— 3	— 3	
Total membership, beginning of Philadelphia meeting	392	407	50
Grand Total	849		
Net gain during 1926	35		

[1]Last report showed 386 associate members—should be 390.

E. A. Hartley, an active member, died from an acute attack of appendicitis October 15, 1926, at the age of 33. Prof. Hartley graduated from Oregon Agricultural College and later studied at Ohio State University. At the time of his sudden death he was teaching Entomology in the New York State College of Forestry.

Dr. Henry Skinner, Vice-president of the Philadelphia Academy of Natural Sciences, entomologist and physician, and an active member of this Association, died May 30, 1926, aged 65 years. He had been connected with the above museum for a long period of years.

D. B. Young, an active member, died suddenly at Albany, N. Y., April 5, 1926, aged 66 years. He served for nearly 25 years as Assistant State Entomologist of New York. He was also curator of insects in the State Museum at Albany.

Harold W. Fitch, an associate member, last residing at Claremont, N. H., died May 16, 1926. He studied at Cornell University and was later connected with the Niagara Sprayer Company located at Grand Rapids, Mich.

John A. McLemore, William M. Mingee, Junior Entomologists, U. S. Bureau of Entomology, employed by Division of Truck Crop Insect Investigations, Sweet Potato Weevil Eradication, were foully murdered near Picayune, Miss., On February 18, 1926. Both men were graduates of Mississippi A. & M. College.

The 11th annual meeting of the Pacific Slope Branch was held June 17, 1926, at University of California, Berkeley, and June 18 at Mills College, Oakland, Calif. The meeting was well attended and the proceedings published in the October JOURNAL.

The Cotton States Entomologists convened February 3–5, 1926, at Biltmore Hotel, Atlanta, Ga. This was the first meeting of this body since becoming a Branch

of this Association at Kansas City, December 30, 1925. The meeting was well attended and the proceedings published in the August number of the JOURNAL.

In March 1926, Dr. E. P. Felt was chosen by the Editorial Board to represent this Association on the Editorial Board of the American Yearbook.

Common names of insects approved for General Use by the American Association of Economic Entomologists was printed in the JOURNAL, June 1925, and a supplement to the above list was printed in October 1926.

Five hundred separates of each of these lists were printed—25 cents being charged for the main list and 15 cents for the supplement. Sales have been rather small and the amount received has been credited to the Association fund.

JOURNAL OF ECONOMIC ENTOMOLOGY

The volume of the JOURNAL for the past few years contained:—

520 pages in 1921;
446 pages in 1922;
568 pages in 1923;
693 pages in 1924;
872 pages in 1925 and
895 pages in 1926

an increase of 23 pages during the past year and 375 pages in the last six years. The size of the volume has steadily increased during the past six years without it having been necessary to increase the cost of subscriptions. The steady annual gain in membership each year in the Association adds materially to the subscription list. There is a substantial balance in the treasury and it is still possible to further increase the size of the volume on the assumption that printing prices remain about the same as during the last two years. The size of the volume and quality of the matter contained therein together with the fair price for subscriptions is satisfying to subscribers.

Complete sets of the JOURNAL are still obtainable excepting No. 2 of Vol. 1 which is out of print. Volumes 8, 11 and 18 have been selling for $4.00 and Volume 12 for $5.00. It has been necessary to advance the price of Volume 18 to $4.00 because of an error by the printer in printing less than the number ordered. On foreign orders 50 cents additional is charged for postage.

Some new subscriptions have been secured during the year by members who also have co-operated and assisted generally in securing new members which results in added subscriptions.

The following table shows the total domestic and foreign subscribers in 1913, 1922, 1925 and 1926.

	1913	*1922*	*1925*	*1926*		*1913*	*1922*	*1925*	*1926*
Alabama	3	12	9	7	Georgia	6	9	12	13
Arizona	7	6	10	14	Idaho	2	4	5	8
Arkansas	2	6	5	5	Illinois	30	28	33	36
California	34	63	95	112	Indiana	16	13	14	15
Colorado	7	14	15	16	Iowa	5	12	16	17
Connecticut	10	20	16	19	Kansas	16	17	22	23
Delaware	3	3	5	6	Kentucky	4	6	4	4
Dist. of Col.	50	53	56	60	Louisiana	12	13	17	22
Florida	7	20	22	27	Maine	5	5	9	9

	1913	1922	1925	1926		1913	1922	1925	1926
Maryland	11	10	12	11	Tennessee	6	11	13	12
Massachusetts	48	83	75	70	Texas	16	25	26	32
Michigan	15	12	14	15	Utah	8	13	11	10
Minnesota	10	14	16	15	Vermont	1	1	2	2
Mississippi	4	25	29	32	Virginia	7	15	19	18
Missouri	8	13	15	17	Washington	8	12	13	12
Montana	5	9	11	10	West Virginia	5	5	7	6
Nebraska	3	2	5	5	Wisconsin	6	15	17	18
Nevada	1	2	2	3	Wyoming	0	1	2	4
New Hampshire	4	7	10	11					
New Jersey	14	23	30	38	Total for U. S.	520	768	926	999
New Mexico	3	3	2	3	U. S. Possessions	26			
New York	52	61	84	89	Hawaii		11	10	11
North Carolina	6	9	11	14	Panama & Virgin				
North Dakota	0	1	2	1	Islands		2	3	3
Ohio	22	33	47	50	Philippines		5	3	4
Oklahoma	2	4	5	7	Porto Rico &				
Oregon	10	11	12	18	Cuba		6	10	13
Pennsylvania	18	39	48	43	Canada	27	43	42	50
Rhode Island	3	2	5	5	Foreign	132	163	245	257
South Carolina	4	1	14	13					
South Dakota	1	2	2	2		705	998	1239	1337

It will be noted from the above table that a gain of 98 subscriptions was made during 1926 against 115 in 1925—three-quarters of the gain of the current year having come from the United States.

Index to the Literature of American Economic Entomology, I and II

The accounts of these two volumes have been combined since June 1925 at which time all indebtedness to the Association had been made up. The sales for these numbers have been limited during the year owing to the fact that the price is rather high and the demand pretty well supplied. There is still remaining on hand a goodly supply of copies for sale.

From this combined account $675.00 was loaned in 1925 for publication of Index III, none of which has yet been paid back. There is now a balance of $346.31 in this account. (See financial statement.)

Index to the Literature of American Economic Entomology III

In my report of 1925 it was stated that $1,675 was borrowed from Association and Journal accounts to assist in financing the publication of Index III. During the current year $100 has been returned to the Association thereby canceling its indebtedness. Also $400 was returned to the Journal account. The financial statement shows the details of this fund.

The sales for this Index have been fairly good during the year but it will probably require two more years before the three Indices as a whole will be free from indebtedness. There is still on hand a liberal supply of copies of this Index.

Advertisement of our publications is run in each issue of the Journal.

Permanent Fund

In accordance with instructions from the Executive Committee, $500 was transferred from the Association Fund to the Permanent Fund. The interest on Liberty Bonds and on Savings Bank deposits has been credited to this fund, as shown in the financial statement. No applications for life membership have been received during the year which would ordinarily be accredited to this fund.

Association Statement

Balance in Treasury, December 7, 1925		$ 887.64
Amount received from dues and separates		1256.77
Amount received from bank interest		20.00
Amount received from loan to Index III		100.00
Paid—Stenographic Report, 1925	$ 201.97	
Postage	72.20	
Programs and Notices	19.41	
Supplies and Stationery	17.97	
Telegrams and Express	14.78	
Returned Checks and Collection charges	6.65	
Expenses of Pacific Slope Branch	13.40	
Funds transferred to Permanent Fund	500.00	
Secretary	100.00	
Clerical work, Secretary's Office	52.25	
Miscellaneous Expenses, Secretary's Office	4.50	
Binding	6.00	
Mimeographing	5.00	
Legal Fees	5.00	
	$1019.13	
Balance, December 3, 1926	1245.28	
	$2264.41	$2264.41

Balance, Deposited in First National Bank, Malden, Mass.

Journal Statement

Balance in Treasury, December 7, 1925		$2118.25
Amount received from subscriptions, reprints, advertising, etc.		5065.36
Amount received from loan to Index III		400.00
Amount received from bank interest		55.42
Paid—Postage	$ 249.10	
Printing	3445.56	
Programs and Notices	10.00	
Supplies and Stationery	36.90	
Half-tones and engravings	286.47	
Telegraph & Express	8.50	
Returned Checks	6.50	
Editor	200.00	
Clerical Work, Editor's Office	95.00	
Secretary	100.00	

Clerical Work, Secretary's Office		52.25	
Miscellaneous Expenses, Secretary's Office		8.08	
		$4498.36	
Balance, December 3, 1926		3140.67	
		$7639.03	$7639.03
Balance, Deposited in First National Bank, Malden, Mass.	$2616.91		
Balance, Deposited in Melrose Trust Company, Melrose, Mass.	523.76		
	$3140.67		

INDEX I AND II

Balance in Treasury, December 7, 1925			$ 60.06
Received from sales			283.00
Interest on Deposits			12.00
Paid—Postage		$ 8.75	
Balance, December 3, 1926		346.31	
		355.06	$ 355.06
Balance, Deposited in First National Bank, Malden, Mass.			

INDEX III

Balance in Treasury, December 7, 1925			$ 35.11
Interest on Deposits			3.19
Amount received from sales			497.68
Paid—Postage		$ 12.64	
Payment on loan from Association		100.00	
Payment on loan from Journal		400.00	
Balance, December 3, 1926		23.34	
		$ 535.98	$ 535.98
Balance, Deposited in First National Bank, Malden, Mass.			

INDEBTEDNESS OF INDEX III

Index III owes Indices I and II	$ 675.00	
Index III owes JOURNAL	500.00	
Total indebtedness	$1175.00	

PERMANENT FUND

Deposit, Melrose Savings Bank, December 7, 1925	$1789.01
Interest on Deposits	67.66
Interest on Liberty Bonds	65.88
Paid into Permanent Fund from Association	500.00
Deposited, Melrose Savings, Bank, December 3, 1926	$2422.55

4¼% Liberty Bonds	1600.00
GRAND TOTAL	$4022.55

SUMMARY

Balance in Indices I and II Account, December 3, 1926	$ 346.31
Balance in Index III Account, December 3, 1926	23.34
Balance in Journal Account, December 3, 1926	3140.67
Balance in Association Account, December 3, 1926	1245.28
GRAND TOTAL	$4755.60

Respectfully submitted,
C. W. COLLINS, *Secretary*

Voted that the report be accepted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

The Cotton States Branch of the Association held its first meeting at Atlanta, Georgia, on February 3, 4, and 5, 1926. Prof. E. N. Cory, delegated by the President, represented the parent Association at this meeting.

Your President attended the 11th annual meeting of the Pacific Slope Branch, held at Berkeley and Oakland, California, on June 17 and 18, 1926. Other members of the Executive present at the meeting were First Vice-President, Carl J. Drake and Second Vice-President W. B. Herms.

At the request of the Secretary, the President secured the approval of all of the members of the Executive Committee to transfer the sum of $500. to the permanent fund of the Association.

As recommended in the report of the last Executive Committee, the President appointed George A. Dean (Chairman), D. J. Caffrey, J. J. Davis, Carl J. Drake and L. Caesar as an advisory committee on research work on the control of the European corn borer, such committee to convene with a similar advisory committee appointed from among the members of the American Society of Agronomy.

At the Kansas City meeting, one year ago, a resolution was adopted approving of the appointment of a standing committee on Insect Pest Survey. Your President, therefore, appointed as members of such committee the following: C. R. Crosby, (Chairman), L. A. Strong, R. W. Harned, R. A. Cooley and J. M. Swaine.

One year ago, too, it was resolved to form a standing committee on programme consisting of three members, to confer with a similar committee of the Entomological Society of America, regarding improvements in our programmes. The following committee was duly appointed: A. F. Burgess, (Chairman), W. E. Britton, and C. H. Hadley.

The resolution adopted at the Kansas City meeting regarding the appointment of a committee to bring together information on arsenical residues on fruits, resulted in the appointment of the following committee: W. B. Herms, (Chairman), Leroy Childs, and A. J. Ackerman.

With reference to the proposal to hold the Fourth International Congress of Entomology in the United States in 1928, your President appointed a committee of four

to consider financial and other arrangements. The personnel of this committee is L. O. Howard, (Chairman), Herbert Osborn, J. G. Needham and W. J. Holland.

As recommended in the Report of the Executive Committee presented at the Kansas City meeting, your President appointed S. I. Kuwana, of Yokohama, Japan, to represent the Association at the Third Pan-Pacific Science Congress held at Tokyo, October 27 to November 9, 1926.

At the last annual meeting, recommendations regarding delinquent members were proposed by the Committee on Membership. These, however, were referred to the incoming Executive Committee. The recommendations have been duly considered and a notice indicating action taken was published by your Secretary in the April issue of the JOURNAL OF ECONOMIC ENTOMOLOGY.

The First National Congress of Soil Science will be held at Washington, D. C., June 13 to 22, 1927. Our Association has been requested to send delegates to this Congress; your Committee would therefore recommend that the incoming President appoint two delegates to co-operate with the Organizing Committee in making the necessary arrangements, and carrying out the plans for the meeting of the Congress.

It has been the practice as the result of an agreement between the Association and its Branches and Sections, to nominate as Second, Third, Fourth and Fifth Vice-Presidents, the Chairmen of the various Branches and Sections, which action makes them members of the Executive Committee, in the opinion of the present committee it would seem that a better continuity of effort in future would result if the Secretaries of the Sections were also members of the Executive Committee. Regarding future members of the Executive, your committee therefore recommends for your consideration the following change in the constitution: Article III, Section I, officers—insert the words "and the Secretary of each branch or section" after the word "officers" on line 5.

The Executive Committee have audited the books of the Secretary and found them to be correct, and proper endorsement has been made in the cash book.

Respectfully submitted,

ARTHUR GIBSON J. I. HAMBLETON
C. J. DRAKE W. E. HINDS
W. B. HERMS C. W. COLLINS
L. A. STRONG *Committee*

Voted that the report be accepted and the recommendations adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Representative to the National Research Council.

REPORT OF THE REPRESENTATIVE TO THE NATIONAL RESEARCH COUNCIL

The National Research Council has formed eleven divisions as a means of covering the field of science. Of these divisions the one entitled, "Division of Biology and Agriculture," includes the field covered by the work of this society.

On July 1st, 1925, the membership of the Division of Biology and Agriculture included ten members at large, thirteen representatives of societies, three liaison connections, a chairman, vice-chairman and a retiring chairman, providing, of course, that the chairman, vice-chairman, and retiring chairman do not serve also as

members in any of the preceding groups. Apparently the total possible number of representatives, (29), was thought to have proven unwieldy and an effort was set on foot looking toward reorganization of the division to the end that the number of members might be materially reduced and the efficiency thereby increased. Early in 1925 a committee was at work on this project. It has continued its work during 1926 and the division representatives on April 25th, 1926, approved the proposed reorganization. This reorganization, through the medium of combining societies for representation purposes, has produced a plan which reduces the membership of the division from a possible twenty-nine to a possible seventeen. It may be of interest to you to see the proposed combination of societies and the following table will serve to cover this point.

At Present		Proposed	
Name of Society	Number of Representatives as members of division	Name of Society	Number of Representatives as members of division
Botanical Society of America	1	Botanical Society of America	1
American Society of Zoologists	1	American Society of Zoologists	1
American Association of Animal Production	1	American Association of Animal Production American Dairy Science Association Poultry Science Association	1
American Dairy Science Association	1		
American Society of Agronomy	1	American Society of Agronomy American Society for Horticultural Science Society of American Foresters	1
American Society for Horticultural Science	1		
Society of American Foresters	1		
American Phytopathological Society	1	American Phytopathological Society Society of American Bacteriologists	1
Society of American Bacteriologists	1		
Ecological Society of America	1	Ecological Society of America American Genetic Association The United Genetics Sections of the American Society of Zoologists and the Botanical Society of America	1
American Genetic Association	1		
		American Physiological Society. Physiological Section of the Botanical Society of America. American Society of Biological Chemists.	1
American Association of Economic Entomologists	1	American Association of Economic Entomologists	1

In cases where societies are combined it is proposed that each society shall designate an elector and that the electors from the societies which are grouped together shall choose from among themselves or from the membership of one of the constituent societies the group representative in the division.

This reorganization is thus seen to reduce a number of society representatives in the division from thirteen to eight. The number of members at large is reduced from ten to six making all told, with a chairman, vice-chairman, and retiring chairman, a total of seventeen.

So far as your representative can see, this reorganization, in so far as it affects the American Association of Economic Entomologists at all, affects that society favorably. It is your representative's understanding that this plan of reorganization of the Division of Biology and Agriculture, which was approved by the composition of the division on April 25th, 1926, is now up for adoption by the constituent societies.

Your representative, on the basis of his brief experience in this work, would like to offer a suggestion for your consideration, namely, that the representative of the American Association of Economic Entomologists to the National Research Council, serving as a member of a Division of Biology and Agriculture, be given a term of three years as is a common practice in most of the other constituent societies. This will provide for continuity of effort and should automatically give to the society more influence in dealing with division matters.

THOMAS J. HEADLEE,
Representative of the American Association of Economic Entomologists to the National Research Council

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The report of the Committee on Policy is next.

REPORT OF THE COMMITTEE ON POLICY

The personnel of the subcommittees during the current year is as follows:
Technical Training and Research: Messrs. Headlee, Swaine and Ruggles.
Regulatory and Control: Messrs. Burgess, Gibson and Collins.
Insecticides: Messrs. Parrott, Headlee and Haseman.
Publicity: Messrs. Collins, Felt and Burgess.

At the last annual meeting it was voted that the report of the Committee on Endowment be accepted with the exceptions of Sections 1 to 6 which were referred to the Committee on Policy. That differences of opinion prevail is suggested by the foregoing action, and these apparently have arisen because of some doubt relative to future policy with respect to the administration of the funds of the Association and the financial support of the JOURNAL OF ECONOMIC ENTOMOLOGY. Whatever uncertainties may exist in these respects, they may be easily overcome by a few changes in the wording of the original report. Acting on the principle that the administration of the funds and business matters of the Association should be directed by the Executive Committee, the Committee on Policy recommends that the original report be modified as follows:

In place of Section 1 which reads "That the Secretary be authorized to transfer from the Association fund to the Permanent fund each year, such moneys as are not required to meet ordinary running expenses" substitute:

Section 1. That the Secretary shall transfer from the various funds of the Association to the Permanent fund each year such moneys as are approved by the Executive Committee.

Section 2. That the interest on all deposits be transferred annually to the credit of the Permanent fund.

Section 3. That members be urged to become life members, and to facilitate payment of the life membership fee payments be made as follows: Full payment $100.00; 2 payments to be made annually $52.00; 3 payments to be made annually $36.00; 4 payments to be made annually $28.00; 5 payments to be made annually $23.20; each member to be credited with life membership after full payment has been made. It is of course understood that life membership can be conferred only after favorable action by the Membership Committee and approved by the Association, and this membership, like any other class, may be terminated by the Association for unprofessional conduct without the return of the fee.

That Section 4 of the original report be omitted.

That Section 5 of the original report be listed as Section 4 and changed to read:

That the Association create a Board of Trustees for the Permanent fund which shall have charge of all moneys placed in this fund and shall be responsible for their proper investment. It shall make disbursements from this fund subject to the approval of the Association and shall make a report at the annual meeting. This fund shall be audited annually. The Board shall consist of the President of the Association, the Secretary, and three members elected for a term of three years, one member retiring annually. The terms at the first election shall be for one, two, and three years, so as to make the retirement requirement effective. The Board shall select its own chairman.

That Section 6 of the original report be listed as Section 5, which reads:

That the present committee be discharged and a new committee be appointed by the incoming President, to take charge of raising the endowment. It is recommended that the new committee designate a member in each state to secure funds for this purpose.

There is still great need of emphasizing the fundamentals in the development of life and their practical application to economic entomology, since a more general appreciation of these means a better understanding of scientific work as a whole and is bound to eventuate in widespread and more satisfactory support. Since there is no more effective way of presenting scientific truths than through personal conversation, entomologists are therefore urged to use their opportunities to the fullest possible extent.

The need of more generous support for systematic work and investigations along the line of pure science may frequently be presented very acceptably in connection with discussions of economic projects and the connection between the two should be pointed out on every possible occasion.

The reports of the subcommittees on insecticide machinery and on lubricating oil emulsions were approved and will be printed in a future number of the JOURNAL OF ECONOMIC ENTOMOLOGY. Since the latter summarizes the more important facts obtained by a large number of workers during the past year and, since there is much interest in the lastest developments of oil sprays, it has been mimeographed so that the information may be readily available to members of this Association.

In view of the many problems involving factors of regional aspects which are receiving the attention of federal workers as well as an increasing number of state entomologists, the Committee on Policy desires to point out that definite benefits would be derived by a closer correlation of efforts. According to present state and national policies, it not infrequently happens that separately organized units are engaged in the same problem with little or no knowledge of other workers in the same field or of the relationship of their various activities to the undertaking as a whole.

It is in overcoming such difficulties that regional conferences can render great service. These enable the different individuals to know each other, promote or develop the spirit of mutual helpfulness, afford a clear definition of the problem, reduce unnecessary duplication of effort and permit a more accurate understanding of state and federal aims relative to financial support. Not only does a need exist for regional cultivation with a group interest at work on problems of outstanding importance, but in some states at least larger provision should be made for funds to enable more frequent consultation between individuals and groups of workers. With certain problems there is little doubt that efforts would be more productive if research workers in entomology would plan for better coordination of efforts and endeavor to operate more as regional units rather than as distinctly separate state and federal units.

That there is some question of the competency of entomological research as conducted at present to furnish satisfactory solution of the problems created by certain injurious insects is indicated by the growing feeling of dissatisfaction with the unbalanced state of knowledge relative to the fundamental principles governing insect life and the opinion that is gradually crystallizing relative to the need of purely fundamental investigations on parasitism, insect physiology, insect ecology, and insect toxicology of inorganic and organic chemical compounds.

Investigational and experimental activities as ordinarily pursued are contributing much to the quality of our knowledge, but it is not so clear that they are adding materially or in the proportion desired to the quality of our knowledge. The foregoing subjects are of fundamental importance both from the point of view of constructive science and from the application of science to human welfare. If not nearly untilled fields, they are surely imperfectly tilled and in competent hands they may prove productive. The fact that we know so little of their potential wealth does not mean that we should always remain in the dark. It would surely be an important and timely thing to attempt to round out our knowledge of insect life by starting intensive and concerted work along the proposed lines. Theory is sound in proportion to its generalizations, but in the absence of facts generalizations can be but imperfect. When the more important facts are firmly established we may perhaps be able to recast many of our theories relative to insect control.

Realizing the importance of the foregoing considerations the Committee on Policy, believing that the time is ripe for taking a progressive step, asks the authority of the Association to secure the opinion of its membership relative to the following questions:

1. What in your opinion is the value of training in Botany, Chemistry, General Zoology, Physics and General Physiology in the technical preparation for research in Economic Entomology.

2. From the standpoint of advancement in methods of insect control, what benefits would likely accrue from the establishment of a great entomological research organization devoting its energies to purely fundamental investigations in such fields as parasitism, insect physiology, insect ecology and toxicology of inorganic and organic compounds?

3. In your judgment which is the better policy—to foster a central research organization or to use the influence of the Association in encouraging members of the staffs of the higher institutions of learning who are capable of conducting productive research along the desired lines?

In the absence of definite data relative to the attitude of our membership and the opinion of others whose views relative to such matters deserves serious consideration, it is not clear at the present time what disposition should be made of the results of this survey. If the opinions generally favor further action, this much is true, that a start has at least been made and the nature and extent of the various steps necessary to secure the desired aims are matters which may well be held in abeyance for future consideration.

P. J. PARROTT, *Chairman* ARTHUR GIBSON
A. G. RUGGLES THOMAS J. HEADLEE
C. W. COLLINS A. F. BURGESS
E. P. FELT J. M. SWAINE
Committee

Voted that the report be adopted.

At the Thursday morning session, after J. A. Manter read his paper on "Charts and Forms as Aids in Teaching Economic Entomology," there was some discussion with reference to the methods of teaching entomology in the various colleges and universities. A feeling was expressed that this Association should have a committee to formulate some program and the more progressive colleges and universities would be glad to avail themselves of the Association's recommendations. It was also brought out that there seems to be no standards of methods used in the various colleges in teaching entomology, a great deal of individuality apparently existing in the methods pursued. After the members were finally informed that a sub-committee of the Committee on Policy ordinarily cares for matters of this kind, President Gibson suggested that the whole matter be referred to the Committee on Policy.

PRESIDENT ARTHUR GIBSON: The next is the report of the Trustees of the Crop Protection Institute.

CROP PROTECTION INSTITUTE

REPORT OF CHAIRMAN OF BOARD OF GOVERNORS BY W. C. O'KANE

Activities of the Crop Protection Institute in 1926 have continued along substantially the same lines as those followed in the last four or five years. The Institute is administering various investigational projects, as noted below, and is publishing the results where conditions warrant publication. The scope of its work is gradually increasing, as more and more industrial organizations entrust it with funds for the prosecution of research.

Direction of the Institute's activities rests with the Board of Governors, three of whom are named by the American Association of Economic Entomologists, three by the American Phytopathological Society, two by the Association of Agricultural Chemists, and one by the National Research Council. The members of the Board for the year just closed have been as follow:

Prof. P. J. Parrott, Geneva, N. Y. Dr. M. F. Barrus, Ithaca, N. Y.
Dr. N. J. Giddings, Morgantown, W. Va. Mr. W. P. Flint, Urbana, Ill.
Dr. I. E. Melhus, Ames, Iowa. Mr. Paul Moore, Washington, D. C.
Prof. W. C. O'Kane, Durham, N. H. Dr. B. L. Hartwell, Kingston, R. I.
Dr. H. J. Patterson, College Park, Md.

The officers of the Board for the past year have been W. C. O'Kane, Chairman, Durham, N. H., Paul Moore, Secretary, Washington, D. C.

In the course of the year, and in accordance with the constitution, the Board of Governors established a separate depository for the funds of the Institute and elected the secretary, Paul Moore, as treasurer. For a period the Bursar of the National Research Council has acted as treasurer. The change indicated was made to facilitate the work of the Institute and does not lessen the helpful relationships that exist with the National Research Council.

Active projects on hand are as follows:

The copper investigations, which were begun in April 1925, with funds supplied by copper refiners, have continued with headquarters at the Boyce Thompson Institute, at Yonkers, N. Y., and with Dr Frank Wilcoxon as investigator. Some interesting new copper compounds have been worked out, which promise to be of value as fungicides and which will be put to field tests the coming season.

The crown gall studies, supported by the American Association of Nurserymen and an independent committee of nurserymen, with additional funds supplied by the Iowa State College and the University of Wisconsin, have continued, with headquarters at Madison and Ames. The investigators employed have been: Dr. A. J. Riker, Mr. L. W. Boyle, Dr. J. H. Muncie and Mr. M. K. Patel. In the course of the present year an appropriation assigned to the Department of Agriculture became available for certain phases of this work, and the organization of the work was rearranged accordingly. The American Association of Nurserymen again voted funds which the Institute is administering.

The study of seed-borne parasites, supported by funds supplied by the Bayer Company, Inc., with Dr. C. R. Orton in charge, continued through the year, with headquarters at the Boyce Thompson Institute.

A second project undertaken on behalf of the Bayer Company, Inc., and supported by a further appropriation, includes investigations of thallium and mercury compounds as insecticides and rodenticides. Headquarters of this are at the Boyce Thompson Institute and the investigator is Dr. J. L. Horsfall. This work began in August.

A detailed study of the properties of Flit, a spray manufactured by the Standard Oil Company of New Jersey, continued through the year, with headquarters in New Brunswick, N. J., and Mr. Franklin C. Nelson as investigator. Interesting information as to the insecticidal properties of various materials is accumulating.

A renewal of contract was made with the Miner Laboratories of Chicago, on behalf of the Quaker Oats Company, for a study of furfuramid and related compounds. Necessary funds have been made available and the work will start early in the coming calendar year, with headquarters at Ames, Iowa.

An investigation of tree spray oils, undertaken on behalf of the Standard Oil Company of Indiana, has continued, with headquarters at Urbana, Ill., and additional phases at Lafayette, Indiana. The investigator is Mr. L. L. English. Fundamental information is being secured as to the relation of viscosity, emulsifying agents and similar factors to insecticidal efficiency.

A further project for the Standard Oil Company of Indiana is provided for in a contract signed in June of the present year. This work will include an investigation of the properties of Kip, a household spray, and Bovinol, a cattle spray. Headquarters of this work are at Lafayette, Ind., and the investigator is Harold G. Butler.

The Scalecide investigation, begun four years ago and supported with funds made

available by the B. G. Pratt Co., continued through the year. The investigator is J. W. Miller, located at State College, Pa. Additional phases of the work have been carried out in Illinois, under Dr. H. W. Anderson, and in Massachusetts, under Prof. A. I. Bourne. The project will be brought to a close early in the coming calendar year.

Publications of the year include the following:

Bulletin No. 8, "Colloidal Sulphur: Preparation and Toxicity."

Bulletin No. 9, "Suggestions on the Preparation of Apple Grafts."

Bulletin No. 10, "The Effectiveness of Various Fungicides in Controlling the Covered Smuts of Small Grains."

MR. L. O. HOWARD: I wonder if Professor O'Kane would give us just a little information about the appointment of the bursar of the Research Council.

MR. W. C. O'KANE: The Institute had its own treasurer when it was organized. Then for the convenience of disbursement of funds, the treasuryship was turned over to the bursar of the National Research Council, and then because of the work made necessary by examination of numerous committees and by various lesser matters of that kind, it seemed advisable to Dr. Kellogg and to Mr. Dunn and to the Board of Governors of the Institute to go back to the former plan and maintain an independent treasuryship. That was already provided for in the constitution, so we simply switched back again.

I should add that the relationship with the Research Council remains unaltered. That was the critical point in so far as the Institute was concerned. We wish there shall be no change. That was the wish also of Dr. Kellogg and Mr. Dunn and the other members of the National Research Council, and that is understood. They still have representation on the Board of Governors and still house the secretary and treasurer and still maintain an advisory committee in close relationship with the Institute.

MR. R. B. ARNOLD: What is the advantage in an industrial organization of undertaking a research through a crop protection institute? We are interested in research now in relation to nicotine. I wondered where this Crop Protection Institute might help us.

MR. W. C. O'KANE: If there is no advantage derived from spending the money through the Crop Protection Institute, we hope nobody will do it that way, because individually we have plenty of work on hand. It appears there has been advantage in various cases and of a material nature. I am quite sure that those who have been spending the money that way wouldn't have done so otherwise. For instance, when The Standard Oil Company of Indiana was about to undertake a second

project, they informed us of their wishes to do this but would not unless the Institute handled the money.

I think I should better answer the question in detail privately.

On the Board of Governors is a member from this Association, the American Association for the Advancement of Science, the Pathological Association, the Association of Biochemists and the National Research Council. If that isn't an agreeable arrangement, I don't know what could be. That gives a sort of prestige, or whatever you may call it, to the Institute and it gives an entree with the experiment station directors and university presidents which means a provision of facilities that would not otherwise be obtained in many cases. It also means a critical review of the results of any investigation which is valuable surely to the scientific men themselves as well as to the industries concerned.

There are various other matters that I would be glad to discuss later.

Voted that the report be accepted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Scientific Trustee, Tropical Plant Research Foundation.

REPORT OF THE TRUSTEE OF THE TROPICAL PLANT RESEARCH FOUNDATION

As representative of the Society on the Board of Trustees of the Tropical Plant Research Foundation to fill the vacancy caused by the untimely death of Dr. W. D. Hunter my election was officially confirmed and I took part in the proceedings at the April meeting of the Foundation.

For the information of members not fully acquainted with the objects of the Foundation it may be stated that it is an organization under the supervision of the National Research Council and concerned with the promotion of investigations upon the plant life of tropical regions. It receives support from various sources, especially such organizations as are interested in the development of tropical agriculture and maintains a central office at Washington and at present has a tropical laboratory for investigation of sugar cane problems at Baraguá in Camaguey Province Cuba, financed by the Cuba Sugar Club. Other projects have to do with tropical forest resources and the Foundation is ready to engage on other desirable projects when the means are available.

The entomological investigations, with which we are specially interested, have so far been connected with insects affecting the sugar crop. The entomologists on the staff of the Baraguá laboratory include the resident Director Prof. D. L. Van Dine, Mr. C. F. Stahl who is engaged especially upon a study of the insect vectors for the mosaic disease of sugar cane and Mr. Planck who is working on the sugar cane borer and its parasites.

The foundation is publishing two series of papers, one a general series intended especially for the use of the sugar growers of Cuba and one of these is devoted to the insects affecting sugar cane, prepared by Prof. Van Dine; the other series consists of reprints from scientific journals and in this series two papers have appeared devoted to the Homoptera related to sugar cane or those which may have a possible connection with mosaic transmission.

The object of our society's representation on the Board of the Foundation is obviously to provide a means for ready interchange of information, and the giving of advice when desired concerning problems connected with the entomological activities of the foundation in any of its enterprises. Your representative will be very glad to answer any questions concerning the organization and to receive suggestions as to meritorious projects or affiliations that may assist in the development of entomological science in the tropics. There is an unlimited field there for entomological research and it seems inevitable that there will be a growing demand for trained entomologists to engage in important economic studies.

HERBERT OSBORN

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: Next we will listen to the report of the Representative on the Council of the Union of American Biological Societies.

REPORT OF THE REPRESENTATIVES OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS ON THE COUNCIL OF THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

The council met at Philadelphia on December 27th. The only business of importance was the reading of the report on "Biological Abstracts" by Dr. J. R. Schramm, Editor in Chief. This report will be published in full elsewhere. The plans for this great undertaking have been thoroly worked out in detail and its success is now definitely assured. It deserves the hearty support and cooperation of all members of our Association.

(Signed)
A. L. QUAINTANCE
C. R. CROSBY

Voted that the report be accepted.

PRESIDENT ARTHUR GIBSON: We will now listen to the report of the Committee on Nomenclature.

REPORT OF COMMITTEE ON NOMENCLATURE

Your Committee on Common Names begs to report that during the past year it has published in the JOURNAL OF ECONOMIC ENTOMOLOGY a supplementary list of 65 names to the first list which it published in the JOURNAL (Volume 18 No. 3, pages 521–545). This now brings the total number of names approved by the Association up to 606.

Your Committee has further considered the names of 56 additional insects which it submits herewith.

To consider these names at the present time would be tedious and we could hardly give the necessary consideration in the time available. With your permission, the Committee would suggest, that we follow the procedure of previous years, and submit this list in mimeographed form to each member of the Association for his or her consideration.

All suggestions for change of the names submitted to be in the hands of the Committee on Common Names, on or before March 1, 1927. Those names, to which less

than 5 objections have been raised to be considered as approved by the Association and published in the next volume of the JOURNAL OF ECONOMIC ENTOMOLOGY.

Your Committee now believes that, though the common names for all of our pests have not been approved by the Association, the majority of these pests most commonly referred to in literature are provided for. We found, in working over the list of common names which we are presenting to you this year, that we were reaching that group of insects for which common names have not been well crystalized in the minds of the entomological workers. We also believe that it is not advisable for the Association to approve names for insects which are not attracting enough attention to have received vernacular names.

If it is the pleasure of the Association to continue the selection of common names for insects, it is respectfully suggested that the membership of this Committee be reduced to 5 and that it be made more representative of the agricultural regions of the United States and Canada.

Respectfully submitted,
EDITH M. PATCH, *Chairman*
ARTHUR GIBSON
Z. P. METCALF
J. E. GRAF
A. N. CAUDELL
S. A. ROHWER
J. A. HYSLOP
Committee

MR. S. B. FRACKER: I should like to inquire of the committee their policy with respect to the scientific names that are included in this list. Is it the policy of the committee to keep in touch with the systematist and recommend or publish changes in the list of scientific names as they have appeared in these lists from time to time or will appear in the future, or is it their expectation that economic entomologists will keep in touch with such changes and make their own changes in the references from time to time?

MISS EDITH M. PATCH: It will be the endeavor of the committee to keep in touch with them.

MR. S. B. FRACKER: If it is the policy of the various economic entomologists to use both the common and scientific names as given in these lists, I would like to suggest that changes of this kind be recommended to this body for adoption when the Committee on Nomenclature is convinced that the changes in the scientific names are sound.

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of Editorial Board (A—Index to Economic Entomology, B—Biological Abstracts).

REPORT ON THE INDEX TO ECONOMIC ENTOMOLOGY AND UPON CO-OPERATION WITH BIOLOGICAL ABSTRACTS

It has been the feeling of your committee in relation to the Index of American Economic Entomology, that inasmuch as Biological Abstracts has just begun publication it is early to make definite plans in relation to bringing the Index down to-date, and with this in mind we were inclined to keep the matter open another year. It has recently come to the knowledge of the committee that conditions in the Federal Bureau of Entomology are exceptionally favorable for the compilation of another Index, and if the association wishes to continue the Index series, an early decision is advisable. It may be noted in this connection that the Index is an exceedingly compact, serviceable publication which has been available to members of the association at the very nominal price of $1.00 for each year covered in the last two issues. Biological Abstracts while it occupies a much larger field and renders a correspondingly greater service, also costs considerably more. The situation has been briefly summarized and the problem may well come up for discussion and possible decision.

There has been close co-operation between your committee and representatives of Biological Abstracts in determining matter which should be abstracted and the selection of individuals to take charge of various phases of economic entomology. Since this committee may be able to render further service along these lines, it is recommended that it be continued as an organization which may function in the case of need.

Respectfully submitted,
E. P. FELT
C. W. COLLINS
W. E. BRITTON
Committee

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: I will ask Dr. Felt to read the next report of the Committee on United States National Museum.

REPORT OF THE COMMITTEE ON THE NATIONAL MUSEUM

Entomology has developed wonderfully in the past twenty-five years and in its practical aspects finds larger applications in agriculture, forestry and the prevention of disease. There is probably no branch of natural history more intimately related to human welfare. This expansion has created insistent demands for accurate identifications in many groups previously regarded as of little importance and for the ready determination of insects in all stages. In the judgment of the committee, the taxonomic work of the country has not developed on a scale warranted by our economic needs. There is no natural group presenting greater difficulties, and as a consequence requiring more intensive and prolonged training for the most efficient service and yet it is much easier to obtain an appropriation for a definite economic project than to secure funds for the adequate development of the fundamental work in our museums. The time must come when the importance of taxonomic work will be generally appreciated. This can be brought about only by repeated emphasis of the above by those acquainted with the facts.

Private workers are depositing their types or noteworthy collections in the Na-

than 5 objections have been raised to be considered as approved by the Association and published in the next volume of the JOURNAL OF ECONOMIC ENTOMOLOGY.

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If it is the pleasure of the Association to continue the selection of common names for insects, it is respectfully suggested that the membership of this Committee be reduced to 5 and that it be made more representative of the agricultural regions of the United States and Canada.

Respectfully submitted,
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ARTHUR GIBSON
Z. P. METCALF
J. E. GRAF
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S. A. ROHWER
J. A. HYSLOP
Committee

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MISS EDITH M. PATCH: It will be the endeavor of the committee to keep in touch with them.

MR. S. B. FRACKER: If it is the policy of the various economic entomologists to use both the common and scientific names as given in these lists, I would like to suggest that changes of this kind be recommended to this body for adoption when the Committee on Nomenclature is convinced that the changes in the scientific names are sound.

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of Editorial Board (A—Index to Economic Entomology, B—Biological Abstracts).

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Respectfully submitted,
E. P. FELT
C. W. COLLINS
W. E. BRITTON
Committee

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: I will ask Dr. Felt to read the next report of the Committee on United States National Museum.

REPORT OF THE COMMITTEE ON THE NATIONAL MUSEUM

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Private workers are depositing their types or noteworthy collections in the Na-

tional Museum. This cannot be commended too highly. Other entomologists, especially those in institutions without a permanent museum policy are urged to adopt a similar course and at least deposit paratypes in the National collection. It is believed that further co-operation in the exchange of either types or paratypes or of material upon which revisionary papers are based, might be practiced advantageously between some of our large institutions and the National Museum. The latter, now has a tray filing system which makes all such material readily available. The general welfare of science dictates the maintenance of a few large entomological collections and on this continent it is believed that the United States National Museum and the Canadian National Museum should be the preferred repositories.

The gift to the United States National Museum of the extensive collection of water beetles by John D. Sherman, Jr., accords with the policy outlined above. The extensive Casey collection of beetles is now being labeled, transferred and installed in new steel cases, thus making it available for study.

The general and prompt service in the identification of insects given by our National Museum to official and other workers throughout the continent should be met by loyal support and any possible co-operation in securing more adequate facilities.

Respectfully submitted,

E. P. FELT
J. J. DAVIS
O. A. JOHANNSEN
R. W. HARNED
W. E. HINDS

Committee

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Program Committee.

REPORT OF THE PROGRAM COMMITTEE

Chairman A. F. Burgess presented the following recommendations, which had been approved by the Program Committee of this Association and of a similar committee of the Entomological Society of America in accordance with the resolutions passed at the Kansas City meeting.

1. That the preparation of the programs be left in the hands of the Secretaries of the two Societies.

2. That arrangements for the Entomological dinner be placed each year as near the middle of the week as possible.

3. That the place of the next annual meeting be left in the hands of the Executive Committee, with the suggestion that they consider the advisability of holding the annual meeting at a different time or different place from the regular meeting of the American Association for the Advancement of Science, the Executive Committee to confer with the Executive Committee of the Entomological Society of America before making a decision.

4. That before small conferences are called at the time of the annual meetings, the Secretaries of the two Societies be consulted relative to the most desirable time of holding those conferences.

(Signed) A. F. BURGESS, *Chairman*
W. E. BRITTON
C. H. HADLEY

Committee

PRESIDENT ARTHUR GIBSON: This report is open for discussion.

MR. C. L. MARLATT: I have only this thought to introduce and you may accept it for what it is worth: It has occurred to me very often in attending the meetings of this body and of other similar bodies that there is too much reading of papers. I feel rather radically on that point. I may not strike any sympathetic chord in this audience. My thought is simply that the subjects be assembled, classified (that is done now to some extent) and that the persons presenting papers on the results of special lines of work be asked to summarize those papers, put in very brief form the important results, put them clearly enough so that the members will realize what they have obtained, what they have achieved but don't give the details, don't read the paper. If possible, have them give it orally, or read it quickly, and then after the reading of the series of papers that are related, we can have time for general discussion. I think you will add to the interest of the meeting.

I know some other associations have adopted what they call the round table method, which is such as I have described. It has aroused an interest in those associations and societies that was before lacking.

I put this forward simply for what it is worth.

MR. GLENN W. HERRICK: There are two or three remarks I would like to make concerning this: In the first place I am in sympathy with Dr. Marlatt. In the second place it seems to me we might get rid of spending a whole forenoon listening to reports of committees. Those reports perhaps might be condensed a good deal. It seems like rather a waste of time to spend a whole forenoon listening to eighteen or nineteen different reports.

It was also suggested by the speaker that before we hold our meetings separately from the meetings of the American Association for the Advancement of Science, that he favors the meeting next year in Nashville, Tennessee, due to the large number of entomologists located in the South not having had equal opportunities to attend previous meetings.

Mr. BURGESS stated that the suggestions made in the report were made in a way to bring out just such ideas as had been made by Dr. Marlatt and Professor Herrick and that the committee was anxious to know what the members wanted.

In regard to Professor Herrick's suggestion of saving time on reports, I suppose it would be possible for the Association to vote that the reports of these various committees be submitted to the Executive Committee and let it make a brief summary report, if the Association would like to have business done that way. That is a matter for you to consider.

Let's do the thing that will serve the best interests of the greater number of the membership.

MR. E. D. BALL: I am very certain, as the result of the discussion at the time the motion was made to appoint this committee, that the committee did not understand it or has ignored the idea that was in the minds of those people who submitted that resolution. This committee on program was to be a continuous committee which would establish more or less of a policy on program and would pick out symposium topics from year to year and probably decide on what was a symposium topic for this year and for next year and so on, and let that be known in advance so that there could be preparation. A real symposium is something that should have more than one year's preparation; as it is now, a man usually has a month or six weeks to make preparation. The major idea was that we would have more of that type of program and that this committee, by being a continuous committee and taking that into consideration, might map out a tentative future program of four or five symposia and invite people to prepare the results of their life work as a symposium program paper: then we might have invitation programs that are not symposia in which we would invite members, possibly not members of this society, to come before us and discuss topics that would be of vital interest, invite pathologists to discuss before us insect transmitted diseases from the disease standpoint, for instance. Under the provisions of this society as it is organized now, there is no possibility of that unless this committee takes it up and issues an invitation officially from this Association.

I am very sure that the functions of that committee were considered at the time the committee was appointed, and they were much more along that line than to take care of the details of the program, the assembling of papers, the printing, and all of that. It was to be a committee on permanent policy of program, that by having such a committee we could work out and get a very much stronger program than we have at the present time.

MR. A. F. BURGESS: Mr. President, I want to say if this committee has apparently ignored any of the intentions in regard to its creation, it has done so unintentionally, because the committee has striven to find out just what was wanted, just what was in the minds of the members of the Association who put through the resolution last year. We have never been able to get a very clear idea of just what was intended. I have asked numbers who were at the Kansas City meeting and couldn't get definite information. We have done the best we could under the circumstances.

If it was the intention of that resolution that this committee should continue from year to year and map out programs in advance, I want to say there isn't any committee in this Association which would have a harder job.

The program subject is one of the most difficult subjects that we have to deal with. There is no question that we are overcrowded this year.

If it was the intention of the resolution that the committee take up that type of work, then there will have to be a re-arrangement on the program right through, because there are too many papers to permit half a day or more to be devoted to a symposium. If that is what the Association would like to have, we ought to have it, and some way should be worked out so it can be taken care of.

I have quite a good many ideas on programs because I have had quite a lot of experience with them. There are a great many difficulties in making up and handling programs that lots of the members of the Association don't realize.

Dr. Hinds stated that he hoped there would be no special meeting arranged for 1927 other than the regular meeting which would be with the American Association for the Advancement of Science at Nashville, Tennessee. He also stated that it was possible and probable that the Cotton States Branch would arrange their annual meeting at the same time as this Association.

He also mentioned that the railway rates should be considered, as members get fare and a half in connection with the American Association for the Advancement of Science which this Association would probably not be able to get as a separate organization.

MR. A. L. QUAINTANCE: I agree especially with what Dr. Ball has said about the advantages of a symposium type of assembly of papers and discussion. At a symposium we all get a chance to talk. I think the membership here in recent years feel they haven't had a chance to discuss things that have been presented.

Simply to get a reaction from the membership, I move you that there be added to the instructions of the Program Committee, instructions to the effect that next year's program be arranged on the symposium basis.

There are usually at each of our meetings some five or six very prominent entomological subjects. I should think those might be arranged in the form of symposia. I would like to ascertain the feeling of the membership here on a tryout of a symposium type of program for our next meeting. I, therefore, move that that be included in the instructions of the Program Committee for next year.

MR. A. F. BURGESS: Mr. President, I would like to ask if that means the whole program should be a symposium.

MR. A. L. QUAINTANCE: I think it might well be tried that way. If there are a number of relating papers, they could be included in this segregation of subject matter. I would like to see a diversion back to the old type of meeting so we would have time to discuss and exchange opinions on the principal subjects at that particular time.

MR. A. F. BURGESS: I would like to call the attention of the Association to the fact that you have right in the Constitution a statement that all members have equal right to present papers on the program. If you want to do this, and I am not saying that it is not a good thing to do, amend the Constitution so you can do it and do it right.

MR. C. H. HADLEY: I want to bring out one other point in reference to what Dr. Ball has said. Unfortunately, I don't believe any member of this committee was present at last year's meeting. Judging from our conversation with a number of members who were present, I think that it was probably not clearly brought out as to just what this committee was intended to do, and I believe also the same state of affairs exist with reference to the committee from the Entomological Society of America.

I want to point out further, however, that if this committee was intended to be a standing committee, it was not listed in the program as a standing committee.

While I am thoroughly in sympathy with Dr. Quaintance's suggestion and would certainly vote accordingly, it seems to me that you will have to get your committee re-organized, re-appointed, first, because I understand that this committee automatically goes out of existence with the acceptance of its report.

MR. C. J. DRAKE: I suggest we have a double program next year—run a symposium and a regular program and let the people take their choice. Have them going on at the same time. Have the regular papers read and a symposium of the major problems at the same time.

PRESIDENT ARTHUR GIBSON: The Chair is getting rather mixed up. I understand there is a motion before the house that the meeting next year take the form of a symposium, but according to Mr. Burgess, that is unconstitutional and requires a change in the Constitution.

MR. E. D. BALL: I wonder if Dr. Quaintance would accept this amendment to his motion, which would bring it in line with the Constitution: That we have one or more symposia at each annual meeting, to be arranged by this committee. That doesn't interfere with the right of every man to appear on the program.

PRESIDENT ARTHUR GIBSON: Will you accept that amendment?

MR. A. L. QUAINTANCE: Yes.

PRESIDENT ARTHUR GIBSON: We will take the vote on the amendment first. Those in favor of this amendment as proposed, signify by saying "aye;" contrary "no." It is carried.

Now a motion is in order to adopt the report of the Committee on Program, in line with this suggestion.

MR. W. C. O'KANE: We have all presented papers before the Association and taken up too much time on details. Why can't we get down to the point of presenting the results of papers in three or four minute abstracts, combining that with symposia in which we may discuss at length and at liberty important entomological problems, thereby gaining the advantages of a program in which men present here for the first time results of work they have done and an opportunity for free discussion of big entomological problems.

MR. C. L. MARLATT: The last speaker has very much the idea that I had in mind in my original remarks, that is, have the papers on a particular subject grouped, and then have them abstracted and limit them to two minutes. That would save eight minutes on every paper. In that way you would save enough time for discussion. By adopting in this connection the thought of abstracts, of presenting a brief summary of the reports, you would gain a lot of time. I think, then, the difficulties that have been mentioned would disappear. The papers that didn't fall into any of these symposia or general subjects would be relegated to a group by themselves to be taken up in the old form, except that they also should be presented by abstract or in a brief statement.

If it is proper, I would like to move that the committee be instructed to consider and adopt this abstract idea as well as the symposium idea, combine the two so far as the papers can be so combined, and then classify the odd papers by themselves.

The motion was carried.

A motion was then made that the report by Chairman A. F. Burgess be accepted and the committee continued to carry out the further work with respect to program.

The motion was seconded and carried.

At the final business session there was considerable discussion about the status of the program committee in that the Committee on Nominations had not included in their report the personnel of the committee for 1927. A motion was made and carried that the program committee be made a permanent or standing committee.

PRESIDENT ARTHUR GIBSON: The next is the report of the committee investigating arsenical residues on fruit.

Professor Essig read the report.

PROGRESS REPORT OF COMMITTEE TO INVESTIGATE ARSENICAL RESIDUES ON FRUITS AS THE RESULT OF SPRAY PROGRAMS

This committee is the result of a resolution adopted by the American Association of Economic Entomologists at the December, 1925, meeting in Kansas City. The committee was appointed by President Arthur Gibson under date of April 7, 1926, and consists of the following members, Mr. A. J. Ackerman, U. S. Bureau of Entomology, Washington, D. C., Mr. Leroy Childs, Hood River, Oregon, and Prof. W. B. Herms, University of California, Chairman.

Owing to great intervening distances it has not been practical for the members of the committee to meet as a body, hence correspondence has been resorted to. Each member has carried on such work as was possible in his immediate vicinity, and has exercised all possible influence in furthering the objective of the committee.

The chairman has attended several Pacific Coast meetings of entomologists at which spray programs and methods for codling moth control were intensively discussed. At one of these meetings, fortunately, two members of the committee (Herms and Childs) were present and a conference between the two was made possible. Through the splendid co-operation of President Arthur Gibson of the American Association of Economic Entomologists, and other workers in various parts, particularly the apple and pear growing sections of the Pacific Coast, the chairman has been able to accumulate a mass of material pertaining to the problem at hand. Since the results of much of this season's work are still unavailable, this report can perhaps only enumerate lines of attack that have been employed in many of the fruit growing districts of the country where codling moth control is necessary.

1. Control of the first brood of moths.
2. Making early sprays more effective.
3. Removal of residue by either mechanical or chemical means.
4. Supplemental methods.
   a. Banding trees
   b. Orchard and packing house sanitation.
   c. Baiting moths.
5. Substitutes for arsenicals.
   a. Petroleum.
   b. Sodium fluosilicate.
   c. Nicotine sulfate.

The following general conclusions and recommendations are presented at this time.

1. Although arsenicals have been used for codling moth control for a great many years, the present serious residue situation which gives no promise of lessened tension, behooves all concerned to give serious consideration to other means of codling moth control. It is the business of the economic entomologist to help the grower to produce a marketable crop. For the immediate future it appears that arsenate of lead is the only practicable insecticide which can be used with good effect in preventing codling moth injury to apples and pears. Much work has been done during the past season with other insecticides, notably oil sprays, but the results of this work as have reached this committee are either conflicting or very fragmentary or as yet incomplete,

hence no general recommendation is possible, except to urge that this experimentation be continued and that greater effort be made to coordinate the same.

2. Although the committee is not disposed to argue the question of tolerance and on the contrary recommends that the utmost endeavor be made by all concerned to meet the present requirements, it nevertheless trusts that reasonable leniency will be exercised in the administration of tolerance during this period of readjustment.

3. While some attention has been given to the parasites of the codling moth, the matter of control of this insect by this means has as yet not been thoroughly investigated. In view of the work of Flanders with egg parasites this line of investigation would seem to be highly desirable.

4. In spite of the fact that an enormous literature concerning the codling moth has accumulated based on more or less careful research, there is badly needed a modern fundamental investigation of this insect particularly in relation to ecology and sensory reactions of the several stages.

Respectfully submitted,
W. B. HERMS
Chairman of Committee

Much credit is due Mr. Arthur Kelsall, Dominion Entomological Laboratory, Annapolis Royal N. S., Canada for information furnished in the preparation of this report.

Voted that the report be accepted.

As the result of a conference on codling moth sprays and arsenical residues on fruits Wednesday afternoon, December 29, a committee on resolutions relative to spray residues was appointed by President Gibson to report Thursday afternoon. The personnel of the committee is as follows: W. C. O'Kane, Chairman, T. J. Headlee, J. J. Davis, E. D. Ball and E. O. Essig.

Suggested committee to formulate plans for investigation of the codling moth from biologic and control standpoints will consist of: A. L. Quaintance, Chairman, G. A. Dean, P. J. Parrott, B. A. Porter, W. P. Flint and Leroy Childs.

Thursday afternoon the committee on resolutions relative to spray residues brought in their report.

SUPPLEMENT TO PROGRESS REPORT OF COMMITTEE TO INVESTIGATE ARSENICAL RESIDUES ON FRUITS AS THE RESULT OF SPRAY PROGRAMS

THE CODLING MOTH OUTLAW

For many years the big problem of the apple grower has been to prevent the heavy losses caused by codling moth worms in July, August and September. In order to meet this problem there has been a growing tendency to concentrate spraying efforts in the late summer months. The plan of late spraying has failed to give the improvement in control that has been expected and desired, and, also, it has resulted in objectionable amounts of spray residue remaining on the fruit at harvest.

At a recent conference of entomologists of the University of California, the State Department of Agriculture and the United States Bureau of Entomology, the following information and recommendations were prepared:

Exterminate First Brood of Worms

There are two fairly distinct broods of codling moth worms with a partial third brood in the warmer districts. The second brood worms cause the severe damage to the apple crop. The second brood are the offspring of the first brood. If the first brood could be completely killed off or practically so, there would not be enough second brood in August to do any serious harm and late spraying could be largely or entirely dispensed with. Herein lies the most promising solution of the codling moth problem.

The first brood worms hatch almost entirely during April, May and June. The program of extermination must be carried on with the utmost intensity during this period. Every measure having any value in destroying the worms should be employed. Spraying is, of course, the most effective method of destruction but if the moths are abundant as is the case in most sections of the state, other measures must also be employed.

The Calyx Spray. The calyx spray ranks with the most important spray in codling moth control. It should be applied when the petals have nearly all fallen. If the application has been unsatisfactory because of windy or rainy weather, or if there is irregularity in the blooming time of different varieties, or if worm control in the past has been especially unsatisfactory, a second calyx spray should be applied before the calyx lobes close. Use an abundance of spray and direct the force of the spray against the blossoms, using spray rods and a tower if necessary.

Cover Sprays for First Brood Worms. The first cover spray should be made before any worms begin hatching. If the weather should turn off warm after the trees bloom the first cover spray should be completed by two weeks after the calyx spray and by three weeks if the weather should remain cool. Use standard (acid) arsenate of lead at the rate of three pounds of powder or six pounds of paste to one hundred gallons of water. In the fog belt near the coast where arsenical injury occurs basic arsenate of lead should be used at the rate of three or four pounds to one hundred gallons of water. Spray thoroughly and apply an abundance of spray for the purpose of completely covering the leaves and bark as well as the apples.

The second cover spray and subsequent ones should be applied with such frequency as to keep the leaves, bark and fruit thoroughly coated with spray up until July 1. This requires that applications should be made at intervals of ten days to two weeks. Follow the same directions as for the first cover spray.

Banding for First Brood Worms. Not all first brood worms will be killed by the spray. Some will escape regardless almost of how thoroughly the spraying has been done. A large percentage of these can be captured and destroyed by placing burlap bands around the trunks of the trees about May 20. The bands should be folded to three thicknesses. The band may be held in place by driving a finishing nail diagonally into the tree and slipping over this the ends of the band. The bands should be examined and the worms destroyed every ten days throughout the summer. This should not be neglected. Rough bark should be scraped from the trunks before banding in order to cause more worms to go under the bands.

THINNING OFF WORMY APPLES. Thinning crews should be especially on the lookout for wormy apples which should be collected in bags and buried or otherwise destroyed. The picking off of wormy apples any time during May and June is worth while for every first brood worm killed may mean the saving of several apples at harvest.

CONTROLLING WORMS AFTER JULY 1. If a large number of first brood worms get by, the battle is lost. Late spraying is much less effective than the sprays made up until July 1. No sprays should be applied later than a month before the apples are to be picked.

In view of the following facts—

1. That there has been confusion as to the exact facts in cases of human disorders that were thought to be due to residues on edible products following spraying.

2. That there is wholly insufficient information as to the limits of safety in such residues.

3. That present official spray schedules have been followed over wide areas and for a long period of years with absence of manifest harmful effects to those consuming sprayed products, even though such products have been freely used.

4. That the health and safety of the public constitute a permanent consideration which must be fully safeguarded.

It is recommended—

1. That the United States Department of Agriculture call in conference representatives of the American Medical Association, a physiological laboratory such as that of Chicago University, interested State Experiment Stations, and others, together with experts in the Department, in order to plan a joint investigation that will disclose the basic facts with reference to tolerance.

2. That the United States Department of Agriculture and the State Experiment Stations undertake further studies intended to disclose new materials that may serve as adequate agents for control of injurious insects, and that a sub-committee of this committee, with Dr. A. L. Quaintance, as Chairman, be authorized to take the necessary steps toward such a program.

3. That the United States Department of Agriculture and State Experiment Stations give special attention to studies of control measures aside from applications of sprays, including such as biological control methods, orchard and garden sanitation and the like,

4. That Entomologists emphasize close adherence to authorized and conservative spray schedules.

W. C. O'KANE
E. D. BALL
J. J. DAVIS
T. J. HEADLEE
E. O. ESSIG

Committee

MR. ALBERT HARTZELL: I would like to say I am thoroughly in sympathy with these resolutions. I think what we need is a lot more work. I don't want to infer from this short paper that this represents very much of the story of arsenic. What we are trying to do is to find out a few more facts regarding arsenical residues. We hope to continue

this work over a number of years. We wish that others in other fruit districts would carry on experiments of that kind. I believe in time we will get more people to see and know where we stand, and then if we have sufficient medical data, I am quite sure that we can arrive at a position where it will be safe to use these sprays.

Voted that the resolutions be adopted.

PRESIDENT ARTHUR GIBSON: Next is the report of the committee for Holding the Fourth International Entomological Congress in America.

REPORT OF COMMITTEE FOR HOLDING THE FOURTH INTERNATIONAL ENTOMOLOGICAL CONGRESS IN AMERICA

MR. L. O. HOWARD: You will remember perhaps my report last year on the Zurich Congress, the third Entomological Congress, the first one having been held in Brussels in 1910, and the second one in Oxford in 1912. At the Oxford Congress there was a strong invitation from the United States, presented by Dr. Skinner, to the Congress to come to the United States in 1915, but it was overruled by the committee and the Congress was appointed for Vienna in 1915, with the understanding that the Congress would come to the United States in 1918. Then came the Great War, which interrupted everything, and there was no Congress until 1925, at Zurich.

The permanent committee expressed a desire to come to the United States in 1928. The matter was submitted to this Association at its last meeting. A committee consisting of Dr. Osborn, Dr. Holland, Dr. Needham and myself was appointed. We have been conducting negotiations throughout the past year and considering all sorts of possibilities. We met yesterday with a committee of the Entomological Society of America, and have phrased the following resolutions which we offer to you:

"*Resolved*, That the American Association of Economic Entomologists extend to the permanent committee of the International Entomological Congresses a cordial invitation to hold the Fourth Congress in the United States of America, and that Ithaca, New York, and the third week in August, 1928, be selected as the place and time.

Resolved, That your committee be continued and that it be requested to act in cooperation with a similar committee from the Entomological Society of America as a joint committee, charged with consideration of further details connected with the Congress."

L. O. HOWARD, *Chairman*
W. J. HOLLAND
HERBERT OSBORN
J. G. NEEDHAM
Committee

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: Report of the Advisory Committee, Entomologists and Agronomists on Research and Control of European Corn Borer, is next.

THE REPORT OF THE JOINT COMMITTEE ON THE EUROPEAN CORN BORER, APPOINTED BY THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS AND THE AMERICAN SOCIETY OF AGRONOMY

The European corn borer, which was first discovered in the western infestation area of the United States in the summer of 1920, has made a natural spread until at the present time (September, 1926) the insect occurs throughout a strip of territory varying from 75 to 150 miles wide in the Lake Erie districts of New York, Pennsylvania, Ohio, Michigan, Indiana, and Ontario. Although drastic measures are being taken to place in operation every known agency to prevent the spread and to reduce the intensity of infestation, the insect is spreading in all directions at a rate of from 20 to 30 miles per year, and the infestation is increasing in intensity.

Those familiar with the habits of the corn borer and those who have observed crop losses in the principal dent corn-growing districts of Ontario, are convinced that the insect is of tremendous potentiality and ranks as one of the most alarming crop pests that has ever become established in America. Threatening as it does the corn crop of this country, upon which the great livestock industry depends for roughage and grain, the situation presents the possibility of a national calamity which calls for the keenest knowledge of the scientist, the wisest judgment of the state and government officials, and the closest cooperation of the growers.

The committee appointed to investigate the possibility of closer cooperation between entomologists and agronomists in combating the European corn borer, wishes to endorse and give its hearty approval to the efforts that have been made to prevent the spread of the corn borer and to commend those engaged in directing the research in this field for the extensive cooperative experiments now under way to develop effective means for the control of the insect. It would seem that little has been omitted in planning and conducting both the quarantine and research work. It is the purpose and wish of this committee to assist in every possible way to marshall all forces in an effort to give every possible support and encouragement to the extensive research now under way. With this purpose in mind, the committee suggests and recommends:

That the state agricultural experiment stations, the state departments of agriculture, and all other agencies interested in the welfare of agriculture give their support and encouragement to the federal governments toward a continuation of present policies in respect to quarantines and quarantine enforcement. Realizing, however, that with the continued spread of the borer, it may be necessary to modify the quarantine and scouting programs within the next few years, that scouting work in the area not known to be infested by the European corn borer, but apparently subject to infestations, be continued, and that the scouting work be extended further to uninfested areas in the large corn-producing states where such areas seem particularly exposed to infestations.

That the cooperative projects in the infested areas now under way between agronomists and entomologists of the state and federal governments to determine the best types, varieties, and strains of corn to use under corn borer conditions be continued. Studies to determine the best time to plant different sorts to escape commercial damage also should be continued. Agronomists and plant breeders should endeavor to find strains of corn which may have some natural resistance. Efforts also should be made to determine the possibility of developing strains which may have some natural resistance. Efforts also should be made to determine the possibility of de-

veloping strains which may be planted at the optimum time to escape severe infestation and yet yield profitable returns. These projects should be continued for a sufficient time to be reliable and to be conducted under different climatic conditions.

That similar projects with respect to types, time of maturing, yields, etc., be started in the corn states not yet infested with the European corn borer.

The continuation of the projects now underway to introduce all effective parasites of the corn borer from Europe and Asia. The enlargement of these projects to include an intensive survey of the parasite possibilities throughout the known world distribution areas of the corn borer. These investigations should include a comprehensive study of the biology, host relationships, etc., of the introduced species after they become adapted to North American conditions.

The continuation of the studies relating to the biology and ecology of the corn borer under North American conditions with special emphasis upon the facts needed for the effective control of the species.

The continuation of biological investigations in the presumed native home of the insect (Europe) with especial emphasis upon the determination of ecological influences responsible for the development of areas of chronically severe, or chronically light infestation, or variable infestation as the case might be, together with the application of these findings to North American areas with the same or similar ecological environment. This involves a study of the influences responsible for one-generation or two-generation development, the status of parasites, variety of crops, damage, seasonal history, cultural methods, control methods, distribution and meteorological data, etc.

That we express our appreciation for the excellent progress that has been made in the development of machinery for cutting corn close to the ground, for ensilage cutting, and for shredding or otherwise handling corn in the field so as to destroy all the corn borers in the stalks and stubble after the corn is gathered. These investigations, together with the studies of attachments to plows that will facilitate the turning under of high stubble or standing corn stalks should be continued.

That the experiments to determine the value of plowing under corn debris as a means of destroying the corn borer larvae be continued. Such studies should include a determination of the comparative value of fall and spring plowing, of different dates and depths of plowing.

The continuation of the field surveys to determine the annual increase in dispersion and intensification of infestation.

Since the burning of the crop residues is an effective means of assisting in the control of the European corn borer, we recommend that further studies be carried on to determine the effect of the burning of corn residues on soil productivity.

That work upon insecticides and chemotaxy be resumed in the hope of finding methods by the use of which the individual grower can protect his crops.

That we recommend to those engaged in research along agronomic and animal nutrition lines that they study rotations with special reference to determining the degree to which it may be possible or desirable to substitute less susceptible crops for corn in those sections where the corn borer promises to become a serious pest.

That we suggest a thorough investigation of the possible further commercial utilization of corn residues.

That further attention be given in one-generation areas to weeds and other plants than corn to determine what part such plants may play in the future as breeding hosts

of the borer, especially in districts where, owing to the severity of the infestation, corn growing may be abandoned temporarily.

That we recommend to the extension service of the state and federal governments that they take every opportunity by demonstrations, exhibits and lectures to acquaint their constituencies with the gravity of the corn borer, the nature of the insect and its work, together with the methods of meeting with the situation. The need of the cooperation of every grower in the regions adjacent to the infested area as well as those within recognized corn borer territory should be emphasized.

That state and government publications be issued to keep the public fully informed regarding the development of the European corn borer situation. Annual mimeographed or printed reports of progress for distribution to interested workers also would be desirable.

That the committee act as a clearing house in advancing corn borer control measures by obtaining opinions from the entomologists and agronomists as to the lines of research and other methods which should be pursued, with special reference to needed investigations not now under way and which may have a practical application to the problem.

That the committee may be of service to the Secretary of the United States Department of Agriculture, the Canadian Minister of Agriculture, and other administrative officials, or to legislative bodies who are charged with making the final decisions in matters regarding appropriations and general policies affecting corn borer research and control by keeping them informed of the progress of the work and of field conditions, and by furnishing needed information relating to results of experiments and the requirements for continued work.

That we recommend that all states where European corn borer occurs, pass legislation at the next session of the legislature, authorizing the state department, in charge of operating quarantines, to stop and search vehicles and other carriers to ascertain if they are carrying corn or other produce that might be infested with the corn borer, and if contraband, to seize or prevent it from leaving the quarantined area. Also, that the states promulgate compulsory clean-up regulations that are adapted to their respective conditions in order to give greater assurance of the destruction of the corn borer.

It is recommended that copies of all written reports or recommendations of the committee be made available to the Secretary of the United States Department of Agriculture, and the Canadian Minister of Agriculture.

Respectfully submitted

GEO. A. DEAN, L. E. CALL
LAWSON CAESAR W. L. BURLISON
J. J. DAVIS J. F. COX
C. J. DRAKE R. M. SALTER
D. J. CAFFREY F. D. RICHEY

Joint committee of entomologists and agronomists.

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Committee on Insect Pest Survey.

REPORT OF THE COMMITTEE ON INSECT PEST SURVEY

The results achieved by the Insect Pest Survey at Washington and the Crop Pest Survey of the Dominion Entomological Branch of Canada have justified the undertaking and these agencies merit the hearty support of all members of this Association. We believe that these agencies should be provided with adequate facilities for extending the work generally throughout the territory, for increasing the number of collaborators and for keeping in personal contact with leaders in survey work throughout the country. Additional facilities should be provided for studying and digesting all data, both current and published, which may throw light on the problems connected with the distribution of insect pests. These agencies should be recognized as special activities with a definite field of effort peculiar to themselves. With more adequate support from our members as collaborators they can function more effectively in sending out information concerning the beginnings of insect outbreaks. Experimental work in the methods of estimating the abundance of insects should be encouraged.

As an aid to the early detection of imported pests we feel that the preparation of State and regional lists of insects should be encouraged. In this way the co-operation of great numbers of collaborators can be secured and many valuable data obtained at a minimum of expense.

(Signed) C. R. CROSBY, *Chairman*
J. M. SWAINE
R. W. HARNED
Committee

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next is the report of the Delegate to the Pan Pacific Congress.

(The report was received too late for reading at the meeting.)

REPORT OF THE DELEGATE TO THE PAN-PACIFIC CONGRESS

I beg to submit herewith a brief report of the session of the Third Pan-Pacific Congress at which I had the honour to represent as delegate, the American Association of Economic Entomologists.

The Congress was held in the General Hall of Tokyo Imperial University and in the Imperial Diet Building, in Tokyo, from October 30 to November 11, 1926. The Congress was attended by roughly speaking, six hundred delegates, of whom two hundred were overseas and the others local representatives.

The work of the Congress was separated into two Divisions, Physical Sciences and Biological Sciences. The latter being subdivided into the sections of Agriculture, Botany, Hygiene and Medicine, Zoology and Fisheries. Joint Divisional and Sectional meetings were held.

Papers on Entomology were chiefly economic in nature and were read in the section of Agriculture and pertained mainly to the subject of information regarding the insect fauna of the Pacific region, particularly insects affecting plants and animals of economic importance. There were no papers on pure Entomology.

An outstanding result of the congress from the standpoint of Economy was the resolution regarding Crop Protection. The Congress recommended and approved the appointment of an international Crop Protection Committee or board, to promote

and coordinate and investigate the crop enemies and related subjects throughout the Pacific region, and when necessary in other regions, such as the West Indies, which have close commercial relations with Pacific countries. It was suggested that a committee be designated to organize such work and provide for its support by the countries concerned, and for the selection of the said international Crop Protection Committee.

The following items were specified for the Committee:

(a) To promote surveys throughout the Pacific area for the purpose of acquiring information as promptly as possible concerning both the known and probable enemies of crops, and also concerning the parasites and other agencies which may be useful in the control of such crop enemies.

(b) To encourage research work necessary for the local control of such enemies, to determine what quarantine methods may be warranted, and to develop better methods of inspecting and disseminating plants and plant products.

(c) To promote the development by each country of larger numbers of trained workers in the general field of Plant Pest Survey and Control.

(d) To obtain agreements and understandings between countries as to giving prompt notification of the appearance of any new and destructive pests, and to secure the cooperation of such countries in the prevention of the spread of such pests.

Among the more important papers read at the Congress were:

S. Matsumura: "Important Insect Fauna of Japan."
"Insect Fauna of the Pacific Region."

G. Okajima: "On the Distribution of the Injurious Insects of the Rice Plant in Japan with Reference to their Extent among the Adjacent Territories of the Orient."

S. Kinoshita: "On the Biology and Control of Cutworms."

W. E. Hoffmann: "Some Insect Pests of the Families Pentatomidae and Coreidae."

O. Shinji: "Aphids found in Japan Proper."

L. B. Uichanco: "Insects in Relation to the Introduced Cultivated Element of the Philippine Flora."

G. H. Corbett: "Insects on Coconuts in Malaya."

B. A. R. Gater: "The Malayan Coconut Zygaenid and its Relation to *Leouana iridescens* in Fiji."

D. T. Fullaway: "*Adoretus sinensis* and its Natural Enemies in the Orient."

I. Kuwana: "Aleyrodidae or White Flies Attacking Citrus Plants in Japan."

Papers in regard to Plant Quarantine were read and discussed at the Divisional meetings of Biological Science. The following were among the more important papers:

D. T. Fullaway: "Some Practical Considerations in Plant Quarantine."

W. T. Swingle: "Safeguarding the Introduction of Plants from Foreign Countries or Distant Regions by Aseptic Propagation in Pest-free Greenhouses."

I. Kuwana: "The Scientific Basis for Plant Quarantine in the Countries of the Pacific."

S. Matsumura: "Plant Quarantine."
C. Harukawa: "The Scientific Basis of Plant Quarantine in the Countries of the Pacific."
H. Yuasa: "On the Advantages of the X-ray Examination of Certain Classes of Materials and Insects Subject to Plant Quarantine Regulations."

Following is a summary of the number and nationality of overseas delegates and visitors to the Congress:—

U. S., 62, Australia 29, Canada 8, Chile 1, China 11; France 8, England 4, Hawaii 11, Hongkong 1, Netherlands 3, East Indies 12, New Zealand 6, Malay 5, Papua 1, Peru 1, Philippines 11, Portugal 1. Total 187.

Local delegates, approximately 400.

Yours very truly,
S. I. KUWANA.

PRESIDENT ARTHUR GIBSON: The next item on the program is the appointment of committees. Your Chairman has pleasure in appointing the following committees:

Committee on Nominations: J. A. Hyslop, Chairman, C. H. Kennedy and R. W. Leiby.

Committee on Resolutions: R. C. Osburn, Chairman, Alvah Peterson and L. S. McLaine.

Committee on Membership (owing to the absence of one member of the committee): Z. P. Metcalf, pro tem.

Is there any miscellaneous business to come before the meeting? Any new business? If not, I shall ask Vice-President Drake to take the Chair.

FINAL BUSINESS

The final business was transacted Saturday morning, January 1, 1927.

PRESIDENT ARTHUR GIBSON: The first item of business is the report of the Committee on Resolutions.

REPORT OF COMMITTEE ON RESOLUTIONS

RESOLVED THAT:

I. We express our appreciation and thanks to the Local committees for the very excellent facilities afforded and entertainments provided for the members of this Association at the Philadelphia meeting.

II. We express our thanks to the authorities of the University of Pennsylvania for their kindness in placing at the disposal of this Association such excellent accommodations for the meetings.

III. The members of this Association at their Philadelphia meeting express their deep regret on learning of the illness of Professor J. H. Comstock.

IV. The special committee appointed by the President to investigate arsenical residues be made a standing committee.

V. The special committee appointed to cooperate with the American Society of Agronomy to investigate European Corn Borer control be made a standing committee.

VI. The President appoint a delegate to attend the meetings of the Cotton States Entomologists, the Southern Branch of this Association, which are to be held on February 2, 3 and 4, 1927.

VII. The reports of the standing and special committees be presented to the Secretary of this Association and that only summaries of the reports in question be presented orally at the regular meetings of the Association.

VIII. The Program Committee at the next meeting of this Association, provide for at least one symposium; consider the advisability of requesting members to present only a summary of their papers at the sessions, and arrange for a special session for teachers in entomology to consider teaching methods.

IX. WHEREAS, several special meetings and conferences have been called informally, interfering to some extent with our regular program; *Resolved*, That any individuals or groups desiring to call special meetings or conferences in connection with future meetings, be requested to confer with the Secretary of this Association before arranging for them.

(Signed) ALVAH PETERSON
L. S. MCLAINE
R. C. OSBURN, *Chairman*

It was voted that the first six resolutions be adopted.

There was some discussion on Resolution 5 before Resolutions 1 to 6 were adopted. The question was raised as to the wish of the Association whether the Corn Borer Committee was to carry over another year or was the present committee discharged. No action was taken at the first reading of the resolutions committee report. President-Elect Harned, however, ruled that that committee will stand until a new committee is selected and it was voted that the committee as it now exists be accepted as a standing committee.

Resolution 7 was re-read and discussed, It was voted that this resolution be adopted with the understanding that the chairman of the various committees give the oral report before the Association.

Resolution 8 was read and explained by R. C. Osburn as follows:

MR. R. C. OSBURN: I think in part this was meant to shorten our program in the presentation of papers and also as suggestions for the Program Committee in regard to these two items. A symposium has been desired by many, also this special session on the discussion of teaching methods in entomology. To give room for two such discussions as those, it would probably be necessary to shorten the presentation of the papers.

Voted that Resolution 8 be adopted.

Resolution 9 was read and explained by R. C. Osburn as follows:

MR. R. C. OSBURN: I think that is only just. If such meetings can be arranged in conference with the Secretary or the officers of the Association, it will avoid any confusion whatsoever. It won't break up work, then, that is regularly arranged for. No doubt such "side shows" could readily be provided for and time found for them without much interference if the Secretary, who has the program in hand, could be consulted.

Voted that resolution 9 be adopted.

It was then voted that the whole report be adopted.

PRESIDENT ARTHUR GIBSON: Next is the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

The committee on membership submits the following report:

1. It recommends for election to associate membership the following 88 persons:

McGinnis, G. R.
Lawson, Paul B.
Abercrombie, H. T.
Arnold, R. B.
Baldwin, R. S.
Grady, H. J.
Grossman, E. R.
Hawkins, J. H.
Atkinson, N. J.
Davis, E. G.
Richardson, H. H.
Dirks, C. O.
Polioka, J. B.
Haegele, T. W.
Campbell, C. F.
Haeussler, G. J.
Daviault, Lionel
Pope, J. B.
Powell, Adinor R.
Marshall, James
Nelson, F. C.
Osterberger, B. A.
Craig, F. W.
Williams, V. E.
Nikolsky, V. V.
Boyce, A. M.
Walsh, S. G.
Borden, A. D.
Griffin, E. L.
Lipp, J. W.
Sherman, Franklin III
Hervey, G. E. R.
Hambleton, E. J.
Garthside, S.
Blisard, T. J.
Chapman, W. W.
Grant, D. H.
Stone, M. W.
McPhail, M.
Dibble, C. B.
Arbuthnot, Kenneth D.
Tolles, G. S.
Proper, A. B.
Christenson, L. D.
Ross, T. S.
O'Dell, J. H.
DeCoursey, R. M.
Reynolds, G. D.
Farrar, C. L.
Sorenson, C. J.
Winter, J. D.
Dove, W. H.
Filinger, G. A.
Roark, R. C.
Worthington, G. V.
Spruijt, F. J.
Pillsbury, A. E.
Drinnan, Dana E.
Wheeler, C. M.
Bailey, J. B.
Brunson, M. H.
Roney, J. H.
Harrison, P. K.
Bottel, A. E.
Tubbs, D. W.
Turner, C. K.
Robinson, Sid
Cooley, C. E.
Dills, L. E.
Lee, J. E.
Dixon, J. W.
Kingwill, H. M.
Kellogg, E. S.
Berryhill, I. W.
Fulton, G. R.
Cockerham, K. L.
Deen, O. T.
Amsler, Fred P.
Steiner, Loren F.
Ginsburg, J. M.
Fagan, J. F.
Miller, P. H.
Poe, S. E.
McDowell, O. S.
Spangenberg, H.
Collier, R. O.
Steenburgh, W. E.
Holdaway, F. G.

2. The committee recommends that the following 35 associate members be transferred to active membership:

Readio, P. A.	Sanders, P. D.	Hoffman, W. A.
Strand, A. L.	Beckwith, C. S.	Jewett, H. H.
Thompson, B. G.	Bedford, Theo.	Kinsey, A. C.
Neiswander, C. R.	Brannon, C. H.	Mitchell, T. B.
Vorhies, C. T.	Brimley, C. S.	Rea, G. H.
Smith, M. R.	Butcher, Fred D.	Ryan, H. J.
Alden, C. H.	Coe, Wesley	Sechrist, E. L.
Bailey, H. L.	Eckert, J. E.	Spuler, Anthony
Kirk, H. B.	English, L. L.	Underhill, G. W.
Batchelder, C. H.	Fisher, W. S.	Whitcomb, W. D.
Eyer, J. R.	Folsom, J. W.	Worthley, H. N.
Trimble, F. M.	Hargraves, E.	

3. The committee recommends that the following persons be re-instated in the Association:

Barnes, P. T. Wallace, F. N.

4. The committee recommends that the resignations of the following members be accepted:

ACTIVE	ASSOCIATE	
O'Byrne, F. M.	Bynum, E. K.	Craighead, E. M.
Rogers, D. M.		Oertel, Everett

Respectfully submitted,
W. P. FLINT, *Chairman*
J. A. HYSLOP
Z. P. METCALF, (Pro tem)
Committee

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next is the nomination of Journal officers by Advisory Committee.

NOMINATIONS OF JOURNAL OFFICERS BY ADVISORY COMMITTEE

Editor—E. P. Felt
Associate Editor—W. E. Britton
Business Manager—C. W. Collins

(Signed) E. N. CORY
FRANKLIN SHERMAN
For the Committee

Voted that the report be adopted.

PRESIDENT ARTHUR GIBSON: The next item of business is the report of the Committee on Nominations.

REPORT OF COMMITTEE ON NOMINATIONS

President, R. W. Harned, A. & M. College, Miss.
First Vice-President, W. P. Flint, Urbana, Ill.

Second Vice-President, (Pacific Slope Branch), R. W. Doane, Stanford University, Calif.

Third Vice-President (Cotton States Branch), Franklin Sherman, Clemson College, S. C.

Fourth Vice-President (Section of Plant Quarantine and Inspection), J. H. Montgomery, Gainesville, Florida.

Fifth Vice-President (Section of Apiculture), F. E. Millen, Guelph, Ont. Canada.

Secretary, C. W. Collins, Melrose Highlands, Mass. Term expires 1929.

STANDING COMMITTEES

Policy:	Arthur Gibson, Ottawa, Ont. Canada. Term expires 1931.
Trustees for Permanent Fund:	G. M. Bentley, Knoxville, Tenn. Term expires 1929.
	E. N. Cory, College Park, Md. Term expires 1928.
	T. J. Headlee, New Brunswick, N. J. Term expires 1927.
Nomenclature:	E. O. Essig, Berkeley, Calif.
	F. C. Bishopp, Dallas, Texas.
	H. B. Hungerford, Lawrence, Kansas.
	H. G. Crawford, Ottawa, Ont., Canada.
	J. A. Hyslop, Washington, D. C.
Membership:	D. M. DeLong, Columbus, Ohio. Term expires 1929.
Advisory Board Journal of Economic Entomology:	J. W. McColloch, Manhattan, Kans. Term expires 1929.
	J. M. Swaine, Ottawa, Ont., Canada. Term expires 1929.
U. S. National Museum:	E. C. Van Dyke, Berkeley, Calif.
Representative to National Research Council:	W. A. Riley, St. Paul, Minn. Term expires 1929.
Councillors to American Association for the Advancement of Science:	G. A. Dean, Manhattan, Kansas.
	G. W. Herrick, Ithaca, N. Y.
Trustee for Crop Protection Institute:	W. C. O'Kane, Durham, N. H. Term expires 1929.
Representatives on Council of Union of American Biological Societies:	A. L. Quaintance, Washington, D. C.
	C. R. Crosby, Ithaca, N. Y.
Representative on Board of Trustees of Tropical Plant Research Foundation:	Herbert Osborn, Columbus, Ohio.

J. A. HYSLOP
R. W. LEIBY
C. H. KENNEDY, *Committee*

Voted that the report be adopted and the Secretary be instructed to cast the unanimous ballot for the Association.

PRESIDENT ARTHUR GIBSON: Will Past President Ball and Past President Dean kindly escort President-Elect Harned to the Chair?

(Past President Ball and Past President Dean escorted President-Elect Harned to the Chair.)

PRESIDENT GIBSON: I take very great pleasure in turning over to you the affairs of the Association for the year 1927. I hope you will have as much pleasure in conducting the affairs of this Association in 1927 as I have had during 1926. (Applause.)

PRESIDENT-ELECT HARNED: I believe it is customary for the man who has been so highly honored to try to make a few remarks. I am simply incapable of doing that on this occasion. I know that no one has ever been so honored who deserves it less. I am sure I have never done anything to deserve this high honor, but I hope it will always make me try to do more and that I shall never do anything that will cause the Association to regret their action in this matter.

I don't want you to think that I am unappreciative or ungrateful because I feel incapable of making any further remarks at this time. (Applause.)

The next item is miscellaneous business.

MR. E. O. ESSIG: There is one, relative to a card index and extract of literature pertaining to insecticides which I was asked to present at this meeting.

Some time ago, Mr. E. R. deOng, who was particularly interested in insecticides, attempted in his own work to get together a card index of all literature relative to insecticides. He proposed not only an index but perhaps also an abstract of this literature. He corresponded quite extensively with certain members of this Association, and particularly with Past President Gibson. Mr. Gibson presented that literature to me, which I summarized as follows:

He suggested the following means for obtaining this index: Either by subscription, for which procedure he estimated $1200 would be necessary, or by actually sponsoring certain groups in the insecticide field, such as arsenic, sulphur, oil, cyanide, soaps, and so on. He had divided this into fifteen different groups.

I understand that some progress has been made in the past. What has been accomplished may be summarized as follows: Four private subscribers on the Pacific Coast have already said they would give $400 to this work. An index of sulphur has been started and is well under way, as is also an index of oils. A great deal of correspondence has been done

between Mr. deOng and Mr. Gibson and other members of the Association.

There are some suggestions which might be thrown out: That this might be undertaken through private subscriptions or by cooperative agencies, such as private spray manufacturers, state experiment stations, federal agencies, etc. A suggestion was made that it might be referred to the International Institute of Rome.

The suggestion which I wish to make at this time, in order to get this matter before the house, is that it be referred to the Executive Committee of the American Association of Economic Entomologists, and for them in turn to refer it to the Editorial Board or to the Committee on Policy as they may see fit.

MR. E. D. BALL: If that is a motion, I will second it.

MR. H. J. QUAYLE: Isn't that subject going to be covered by the Insecticide and Fungicide Laboratory?

Mr. Roark has already prepared one on chloropicrin, and I understand from him it is a very valuable paper. I understand Mr. Roark is going to prepare others on va-ious insecticides and fungicides.

MR. E. O. ESSIG: I might say in that connection it is my understanding that Mr. deOng did get in touch with the Bureau of Entomology and such others as he could. Personally I know of no other way of handling this unless it be sponsored by some definite agency such as has been proposed. That is the reason for proposing this.

The motion was carried.

PRESIDENT-ELECT R. W. HARNED: The next thing is fixing the time and place of the next meeting.

SECRETARY C. W. COLLINS: Mr. Chairman, I move the next meeting be held at the same time and place as that of the American Association for the Advancement of Science, namely, Nashville, Tennessee.

The motion was carried.

MR. R. W. DOANE: The West Coast Branch of this Association is to meet in Reno, Nevada. We should like to see a goodly number of the eastern members of this Association at that meeting. If you do not care to stay long enough to establish your residence there, you may come on out to California and see the conditions out there. We extend to you a very hearty invitation to attend that meeting.

PRESIDENT-ELECT R. W. HARNED: The next meeting will be held in Nashville in the south, and I hope everyone here will be there and that you will bring many more with you, and do everything possible to make it half as good as this meeting. If it is, I am sure it will be a big success.

MR. ARTHUR GIBSON: I move we adjourn.

The motion was carried.

ADJOURNMENT: 11:25 a. m.

PART II. ADDRESSES, PAPERS, AND DISCUSSIONS

The address of the President was delivered at the close of the morning session, Wednesday, December 29, Vice-President C. J. Drake in the chair.

VICE-PRESIDENT C. J. DRAKE: Next on the program is the Annual Address of the President, Mr. Arthur Gibson.

INTERNATIONAL ENTOMOLOGY — RETROSPECTIVE AND PROSPECTIVE

By ARTHUR GIBSON, *Dominion Entomologist, Ottawa, Canada*

ABSTRACT

Some of the developments, particularly during the last decade, which have assisted in bringing about a closer spirit of co-operation in entomological problems international in nature are discussed in the first half of the address. In the latter half—Prospective—the importance of future developments relating to the biological control of insects, national collections of insects, interchange of workers, etc., are emphasized.

Entomology in North America recognizes no national barriers. There are no warning posters along the international boundary between Canada and the United States reading "Keep out—no foreign entomologists admitted." For considerably over one hundred years friendly relations have existed between the two countries and no natural science disputes serious in nature have developed. The science of economic entomology has, indeed, been fortunate in having leaders of broad thought and outlook, and to such leaders we all owe very much, more indeed than any of us can ever repay. Two men especially always stand out prominently in my memory. One of these has long since departed this life, having passed to the great beyond in the year 1908. He was a prince among men—big of heart, broad of mind, wonderfully kind to everyone, passionately fond of the truth, noble in thought and deed, and withal an entomologist of whom Canada has always been proud, one to whom we owe much by reason of the firm foundation he so ably assisted in building and upon which a structure has been erected, the value of which I think is being more and more appreciated as the years roll on. This Association in the early years of its existence was much strengthened by the service he rendered, which service has been acknowledged by others on previous occasions. I refer to the late James Fletcher known and loved by many of the older members here today. It was my great privilege to have had him as my chief for a period of ten years. What this has meant to me can only be appreciated by others who also had the pleasure and help of his comradeship. I realize only too well that had it

not been for the association with and the training I had under Fletcher, I surely would not to-day have the honour of being President of the American Association of Economic Entomologists.

The other man is L. O. Howard whom I first met about twenty-five years ago. No one could have been kinder to me on that occasion. During the years that have followed, he has always shown a most sympathetic interest in our work and has continued to assist us in every way he could. It is unnecessary to comment on the remarkable organization which Dr. Howard and his associates have built up or to the important contributions with which he personally has enriched our literature. All of this is well known to our members.

INTERNATIONAL ENTOMOLOGY—The title of my address—so far at least as Canada and the United States is concerned, had, in my opinion, its real inception with Fletcher and Howard, who were close personal friends.

RETROSPECTIVE

In Fletcher's report as Dominion Entomologist for 1885, we read: "From the geographical position of Canada and the United States, many of our interests and theirs are naturally identical . . . Year after year fresh States of the great republic, whose boundaries touch our own for more than 3000 miles, are added to those who acknowledge the necessity of having a government official who shall devote all his time to studying the habits of insects injurious to agriculture and the methods for controlling and preventing their depredations." In his report for 1899 there is a reproduction from a photograph, showing Fletcher, Lugger and McKellar, searching for grasshopper eggs in Manitoba—a joint investigation made at the request of the Hon. Thomas Greenway, then Premier of Manitoba. In the 29th Annual Report of the Entomological Society of Ontario (1898), there is a very interesting and suggestive paper by the late Prof. F. M. Webster, entitled "Some Economic Features of International Entomology." One of the closing sentences therein reads as follows: "In all of these matters Canada and the United States are one, and this being true, there must be no lines of separation between the entomologists of these two countries. We must work together, shoulder to shoulder, and God speed the day when we shall do this, to even a greater degree than we are now doing."

Now for a few minutes, having in mind the United States and Canada, let us see what actually has developed in bringing about a closer spirit of co-operation in entomological problems international in nature. What are some of the developments, by way of illustration, and without

going back too far, which have taken place say during the last decade?

SPREAD OF GYPSY MOTH PARASITES.—Through the kind co-operation of the United States Bureau of Entomology, officers of the Canadian Entomological Service have been stationed from time to time at the Gypsy Moth Parasite Laboratory, Melrose Highlands, Mass., for the purpose of rearing and forwarding to Canada, useful parasites of the Gypsy Moth, as well as of the Brown-tail Moth. Thousands of specimens of *Apanteles lactiecolor* and *Compsilura concinnata* were thus introduced into Eastern Canada, and have, during recent years, been recovered at several rather widely separated points. In addition, over four thousand specimens of the *Calosoma sycophanta* were introduced.

EUROPEAN CORN BORER—Previous to the finding of the European corn borer in Canada, employees of the Dominion Federal service were allowed to visit the United States to become familiar with the work of the insect and thus develop into capable scouts. Since the discovery of the borer in the province of Ontario in 1920, United States and Canadian Entomologists have had many joint conferences on both sides of the international line.

Ever since the borer was found in North America, federal, state and provincial officers have co-operated closely in all phases of research and quarantine work with the result that there has developed a bond of fellowship, official and personal, an excellent example in fact of international co-operation.

GRASSHOPPER INVESTIGATIONS.—During the recent outbreak of grasshoppers in western Canada, there has been excellent co-operation between the entomologists of Canada and the United States. Joint meetings have been held on both sides of the boundary line which have undoubtedly been of great value to both countries. In this way information regarding the spread of important species was obtained which has assisted materially in outlining and developing future work.

OTHER BIOLOGICAL INVESTIGATIONS.—Much could also be said of the close co-operation which has been developed in connection with investigations relating to the bionomics of white grubs, the Hessian fly, grass-infesting oscinids, certain forest and other insects. All of these investigations participated in by United States and Canadian entomologists are indeed worthy of the highest commendation.

NATIONAL COLLECTIONS OF INSECTS.—During recent years there has been an increasing number of visits of United States entomologists to Ottawa to study material in the Canadian National Collection, and correspondingly more visits by Canadians have of late been made to Washington to examine types and other specimens in the United States

National Museum. Workers in both countries have thus been brought closer and closer together with the result that the two national collections of insects in North America have been enriched by additions of material of great value.

THE NORTHWEST INTERNATIONAL COMMITTEE ON FARM PESTS.—This Committee was organized at a gathering of United States and Canadian entomologists held in Winnipeg, Man., in 1920. The objects at that time were to promote a closer co-operation in grasshopper control, but later it was broadened to include all insects that threatened the crops on either side of the international boundary. The idea, primarily, was to take joint action in controlling pests which might with neglect spread from one part of the country to another. The International Committee on Farm Pests guarded against this by providing that the officials of the territory involved would make every effort to control any important pest that developed, and in addition to such direct action, it was agreed to keep each member informed of impending outbreaks in any particular area and to exchange, freely, information regarding results obtained in control studies incepted. Through this latter arrangement alone, much advanced information has been made available which has had a direct bearing on insect control. Uniform experiments, too, are undertaken by members in the different bordering states and provinces, the results of which are recorded and compared at the annual meetings. Meetings to date have been held at Winnipeg, Man.; Regina, Sask.; Minot, N. D.; Bozeman, Mont.; St. Paul, Minn.; and Lethbridge, Alta. The meetings are quite informal—there are no set papers and no fees. There is no question but that these meetings have been both a direct and indirect means of preventing loss to crops from insect pests, particularly in the case of grasshoppers and cutworms. Their influences in promoting co-operation and good fellowship have been very great.

INSECT PEST SURVEYS.—Since the spring of 1923, the Entomological Services of the United States and Canada have co-operated in presenting to the entomological workers of both countries a monthly summary of current insect conditions throughout their respective territories through the medium of the United States Insect Pest Survey Bulletin and the Canadian Insect Pest Review. These two manuscript publications were brought into being to fulfill the need of a medium whereby current entomological data could be assembled and correlated, and made immediately available to investigators in the field.

The need for insect pest survey work was first recognized and acted upon in the United States, the Bureau of Entomology organizing an Insect Pest Survey in 1921 under the immediate direction of Mr. J. A.

Hyslop. In Canada, in the autumn of 1922, the late Mr. R. C. Treherne, was largely instrumental in establishing an insect pest survey along similar lines and with similar aims to that in the United States.

The exchange of monthly summaries of insect conditions in the United States and Canada is undoubtedly of great value in that they assist entomologists in both countries to form more accurate estimates of the extent and intensity of insect outbreaks. They indicate, too, the presence of incipient outbreaks; give warning of the distribution and spread of injurious species, and record the introduction of new undesirable pests, thus enabling efficient precautionary measures to be taken before the latter are too firmly established.

THE WESTERN PLANT QUARANTINE BOARD.—This organization composed of representatives from the western states, Lower California, Hawaii and British Columbia was incepted in 1919. Meetings are held annually for the purpose of unifying insect and pest legislation in the various states, the reporting of new and serious pests, the consideration of matters of general interest, etc. This Board has accomplished much useful work of an international character.

Let us now go further afield. What has been done in countries overseas to further international entomology? It would take many pages to answer this question fully but if we confine our remarks to comparatively recent years, we will see something of the trend of effort in this connection.

ORGANIZATIONS THAT HAVE ASSISTED.—In Europe, one of the most important agricultural organizations is the International Institute of Agriculture with headquarters at Rome. This Institute was established under the International treaty of June 7th, 1905, which was ratified by 40 governments. Thirty-three other governments have since adhered to the Institute.

So far as entomology is concerned the Institute has taken a deep interest in the development of entomological services in the adhering governments, and in all legislation which in any way affects the movements of plant products and the possible spread of noxious insects thereby. The "Monthly Bulletin of Agricultural Intelligence and Plant Diseases" established in 1909 was continued until 1922, when it was decided to issue a new journal to appear quarterly and known as "International Review of the Science and Practice of Agriculture." In both of these publications brief summaries are given of entomological publications, issued in various countries, and original articles as well, also appear from time to time. In addition to the journals mentioned,

a number of separate monographs have been issued. Those of interest to entomologists are: "The Present Organization of the Services for the Control of Plant Diseases (which of course includes insects) in Different Countries," published in 1914; "The Control Measures Against Locusts in Different Countries," published in 1916; and "The Measures Against the Olive Fly in Different Countries," published in 1922.

At a meeting of the general assembly of the Institute held in April, 1926, it was decided to issue a separate monthly bulletin, on plant diseases and pests, the first issue to appear in January, 1927. Chapter I of the proposed publication, which will it is expected have collaborators in all adhering countries, will relate to discoveries and current events in world entomology and plant pathology; Chapter II, to various questions relating to plant protection in the different countries; Chapter III, to Legislative and Administrative Measures for plant protection; Chapter IV to a bibliography relating to plant diseases and pests, and Chapter V to current notes.

The Imperial Bureau of Entomology, established in 1913, has aided world entomology to a very important extent. Such publications as the "Review of Applied Entomology" and the "Zoological Record" are obviously of international significance. As opportunity offered the Bureau has distributed named sets of insects to institutions in many parts of the world, especially to places where they would be of use in teaching medical entomology. The identification work of the Bureau has always been based on an international outlook and in the past much material has been named for the Dutch Colonies, various South American States, and other countries. Although the Bureau serves as an entomological clearing house for the Colonies and Dominions of the Empire, at the same time, its officers are always ready to render assistance to entomologists of any country.

Conferences in London such as that which took place in 1925, and which I had the pleasure of reporting upon at the Kansas City meeting, are considered desirable at five year periods.

International Congresses and World Conferences.—Since the First International Congress of Entomology held in Brussels in 1910, there have been two further similar congresses, namely at Oxford in 1912 and at Zurich in 1925. All of these conferences were highly successful, bringing together as they did entomologists from the various countries of the world. An important conference too, of plant pathologists and entomologists was held in Holland in 1923. There is no doubt, whatever, that these international gatherings are of great value. They certainly

are the means of establishing important personal relationships and undoubtedly make for better international co-operation.

It has been my privilege to attend two international conferences in Europe and to note the high favour in which our Association is held. The Association although called the American Association of Economic Entomologists, may well be considered international in character. While we include practically all workers in applied entomology in North America, at the same time we have a rather imposing list of foreign members. This foreign list it seems to me could be added to very materially, and I would suggest to our Membership Committee that an effort in this direction be made.

It is of special interest to note that H. R. H. The Prince of Wales in his Presidential Address delivered to the British Association for the Advancement of Science, at Oxford, on August 4th, 1926, referring to the trend of scientific developments said "Nothing but good can follow from personal contact, between scientific workers in different parts of the Empire. Nothing but good can follow from their researches if they add, as gradually they must add, to the wider knowledge of the Empire, not only among the workers themselves, but ultimately among the whole body of informed Imperial citizenship." Referring to meetings of the Association held overseas, he said: "Those of our members who travelled from Great Britain to take part in these meetings have had peculiar opportunities to meet and discuss each his own scientific problems with fellow workers in the Dominions—and it should be added with particular reference to those meetings which have been held in Canada that they have provided almost unique opportunities for personal contact between British workers in science and their American colleagues."

This Association adopted a resolution at the Kansas City meeting, favouring the holding of the Fourth International Congress of Entomologists in America in 1928, and your President, as stated in the report of the Executive Committee appointed a committee to consider possible arrangements.

Prospective

I now come to the difficult part of my address. In these days of intense activity, one is being continually amazed as a result of the advances accomplished in the various sciences. In few fields of research have greater advances been made during recent years than in applied entomology.

You are all familiar with the developments in the use of the airplane for scouting purposes and the application of insecticides; the remarkable progress in the discovery of new and cheaper poisons for insect control;

the application of ecology to insect study; the increased interest in natural control projects, and so on. The future will undoubtedly reveal still more wonderful achievements in the various countries of the world where the entomologist is at work. The entomologist of today hides nothing from his fellow worker; to the stranger too, he delights in the giving of knowledge gained from his researches. In my official travels, particularly during recent years I have had plenty of evidence of this fact. Members of this Association, resident as they are throughout the world, have indeed rendered valuable assistance in developing a bond of good fellowship, the results of which will be even more apparent in the future than they have been in the past.

INTERNATIONAL CO-OPERATION.—It is, of course, to be regretted, that destructive forms of insects take on the bad habit of spreading and thus are no respecters of human property, even that of a neighbouring nation. There are striking records of such migration or introductions, for instance in the case of the Colorado potato beetle, the San Jose scale, the Gypsy moth, the European corn borer, and the Japanese beetle.

In matters looking to the control of a widespread insect, particularly one which has assumed international importance, every co-operative effort which gives promise of assistance should be brought into service. In the years to come this spirit of international co-operation will undoubtedly develop more rapidly and become greatly strengthened by the work of members of this Association. The corn borer conference held in September last at Chatham, Ont., and Detroit, Mich., illustrated a most interesting and valuable advance in international co-operation between the entomologist, the agronomist, the agricultural engineer, and the animal husbandman. At no previous time in the history of applied entomology, has there been such a joint effort to devise ways and means of defeating an insect which has developed into an extremely important international menace. At the final session held in Detroit, at which there were present close to two hundred representatives of various institutions and organizations, a committee was named and approved in conference to assist in the formulation of plans and policies relating to corn borer control.

During the last decade, there has been a marked development in applied entomology in Canada and as a consequence there will be many more opportunities in the future for close co-operation between the workers of the two English-speaking nations of North America.

As regards other nations, this Association can do much to develop a better co-operation between workers in entomology throughout the world. Certain of our members visit from time to time sections of

Europe and other continents and in their association with the resident entomologists have opportunity to discuss problems of one kind or other, which would undoubtedly be solved much more quickly with co-operative effort.

During my term of office, two important committees in addition to the corn borer committee were appointed to deal with matters of international significance, namely insect pest surveys, and arsenical residues on fruits.

THE BIOLOGICAL CONTROL OF INSECTS.—This most fascinating field of endeavour has undoubtedly a most useful future. In almost every country where a broad entomological service is being developed, workers are showing an increased interest in studies relating to the biological control of insects. When Dr. R. J. Tillyard of New Zealand discussed this subject at the First Imperial Entomological Conference, held in London, England, in 1920, there were, in his own words, "more speakers opposed to this method than in favour of it, and the great majority were in a position of doubt, not knowing what to think about it." Since that year, there has, however, been a decided change of opinion, generally. so far as Imperial entomologists are concerned. At the conference held in London in 1925, in fact, it was decided to accept the principle that the Imperial Bureau of Entomology should arrange for the export to Overseas Governments of beneficial parasites. Since, it is of interest to note that the recently constituted Empire Marketing Board had approved of grants to the Imperial Bureau of Entomology, namely a capital grant of £15,000 and annual grants of £4,000 for a period of five years—these grants to be used mainly for parasite investigations.

In no country of the world has the biological control of insects been under investigation to such an extent as in the United States, and the great leader, in all of this work has been our valued member and counsellor, Dr. L. O. Howard.

Officers of the United States Bureau of Entomology, as you know, are searching in a number of foreign countries for parasites of destructive insects which have gained a foothold in the United States. At the Kansas City meeting of this Association a resolution, was approved, "urging the establishment by the United States Bureau of Entomology of foreign field stations wherever advisable for the study of problems pertaining to insects already introduced or likely to be introduced into this country." A similar resolution was adopted by the Entomological Society of America.

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It is not necessary that I should impress upon the members of this Association the value of studies relating to the biological control of

insects. There are, as we all know, a number of very striking instances of success having been obtained in introducing parasitic or other beneficial insects into a country where the host insect had become established and was causing important damage to crops. The entomologists in the Hawaiian Islands, for instance, have had much success in this form of control. At the Pan-Pacific Food Conservation Conference held in Honolulu in 1924, a resolution was passed urging that governments and institutions facilitate the international exchange of parasites in every possible manner and afford to experts of other countries engaged in exploration work of this character all possible assistance.

So far as Canada is concerned the following remarks regarding recent work may be of interest.

In the year 1913 the late Dr. C. Gordon Hewitt, arranged for a shipment of cocoons of the larch sawfly, parasitized by *Mesolieus tenthredinis* to be sent to Canada. The material was received in excellent condition and the parasites were duly liberated in the province of Manitoba where the larch sawfly was abundant. Recoveries of the parasite have been made on several occasions since 1913 but it was not until 1918 that observations indicated a noticeable increase in the numbers of the parasite particularly in an isolated larch swamp eight miles distant from the original place of introduction. Numbers of overwintering cocoons of 1925–1926 were examined and found to be parasitized to the extent of 64 per cent.

In August, 1925, I had a request from Dr. R. J. Tillyard, of New Zealand, for living specimens of Canadian chrysopids to help in checking the ravages of species of *Myzus* and *Myzocallis* on oak trees. On receipt of this communication I requested our officers in British Columbia to make a search for hibernating chrysopids and as a result 1900 specimens were despatched to New Zealand. In reporting upon the arrival of the specimens, Dr. Tillyard said "You will be glad to know that the consignment was highly successful, less than 50 being dead on arrival in Nelson. Of many previous consignments received during the past five years from many parts of the world, we have never succeeded in landing a single live lacewing into New Zealand. This makes the present achievement a most remarkable one and unless the species sent refuses to feed on the aphids we have in New Zealand, the introduction should be a complete success." A report received in March last indicated that a considerable number of eggs had been laid and that the larvae which hatched from them were feeding vigorously on various species of aphids. A later report issued in October stated: "Three generations have already been reared and a fair number have managed to survive the rather too

warm winter of Nelson." At the present time there is enroute to New Zealand a further large shipment of over 5000 specimens of chrysopids.

More recently, at the request of Mr. David Miller, Government Entomologist, New Zealand, I arranged for the forwarding of two shipments of white grubs parasitized by the tachinid, *Microphthalma michiganensis* Towns. The first consignment comprised 1060 tins, the second 500 tins, each containing, in earth, one parasitized grub. The grubs were collected in the neighbourhood of Hemmingford, Que. It is the hope that these parasitized grubs will produce adult flies in New Zealand which when liberated will take kindly to species of chafers of the genus *Odontria*.

As regards parasites of the European corn borer, owing to the very generous assistance of the United States Bureau of Entomology, the Canadian Entomological Service, has developed at Chatham, Ont., an important laboratory at which the European parasites *Habrobracon brevicornis* and *Exoristes roborator* have been reared and liberated in considerable numbers in the province of Ontario, 2,500,000 individuals of the former species, and 120,000 of the latter. Further co-operative work with other European parasites of the borer is in progress.

Plant Inspection. Applied entomologists generally are interested in the future of plant inspection work, the object of which is to prevent the export or import of insects. The responsibility resting upon the shoulders of those who actually do the inspection is very great indeed, and it seems to me in view of the important sums spent in such preventive work and its recognized necessity, the various countries of the world should strive to strengthen inspection services as much as possible and attract thereto a higher type of trained men.

The fact that insects may, through the various agencies of commerce, be transported from one country to another has done much to bring together experts of various countries with the undoubted result that plant inspection services have been better organized and understood generally and are now rendering more efficient service. In all of this development, world entomology, I think, has been helped in no small degree.

At various international conferences during comparatively recent years, discussions have taken place regarding the advisability of appointing international committees to consider matters relating to plant inspection work. So far as I know no definite action has as yet been taken in this regard. It seems only possible to expect that countries situated for instance as are the United States and Canada, could only agree in most general terms to any international insect legislation.

The needs and risks of the various countries of the world are so diverse. Following a study of the Rome convention, a sub-committee, appointed at the Imperial Entomological Conference of 1920 reported that "it is impracticable to frame any such convention to which all countries may be expected to subscribe and which at the same time would have material value." An international committee, however, I think could be highly useful in bringing about, as indicated in a resolution adopted at the Pan-Pacific Food Conservation Conference held in Honolulu, 1924, of international agreements and understandings to provide for the giving of prompt notification of the appearance of new and destructive pests and to secure the co-operation of countries in the prevention of spread of pests.

One of the important needs in applied entomology today is accurate knowledge regarding the larval forms of insects. Consider for a moment one group alone. How many entomologists could determine definitely the more common forms of noctuid larvae—cutworms—particularly in their earlier instars, which occur in their immediate vicinities. I have often wondered why more of our younger entomologists do not investigate this most attractive field of endeavour—one which offers excellent possibilities for original and most valuable research. When accurate information is available of the larvae of even those groups of special economic importance, what a help this will be to those engaged in plant inspection work in the various countries of the world. Dr. Howard had this in mind when he stated in his recent admirable address on "The Needs of the World as to Entomology" "We should not only be able to identify material found in whatever stage, but . . . it is becoming plain that quarantines may be promulgated which are unnecessary. We have been obliged to go on the presumption that a pest in a given country may be and probably will be a pest in another country, but such a decision cannot be made with full justice without a knowledge of the ecology of the species in its original home. It would, virtually, be impossible for any nation to carry out investigations of this kind within the territory of another nation for any number of species without international agreements and without the expenditure of large funds . . .".

Development of National Collections of Insects. We are all agreed that large and well classified collections are of prime importance. Two reasons may be advanced: (1) economic importance and (2) scientific importance. Regarding the former, in order to obtain quick and accurate determinations of insect pests, native or introduced, a well-classified collection for purposes of comparison is absolutely essential. Most of us, I think, could cite examples in support of this.

Regarding the second reason, collections are necessary from the standpoint of pure science in order to trace the relationships between existing insect forms and also between present and extinct forms; in this way one arrives at definite conclusions regarding the phylogeny of the groups and eventually may also form some definite idea regarding the laws of evolution responsible for the present distribution of insect life.

A more comprehensive interchange of material between museums would certainly be an advantage to the science of entomology. Probably the factor which principally operates to prevent this is the universal lack of adequate staffs in museums. As a rule the scientific members of the staff are already hampered by having too much clerical or mechanical work, and thus they shrink from the labour involved in making exchanges with other institutions.

I trust the time will soon come when it will be possible for museums to employ more workers in systematic entomology. Owing to the great multiplicity of insect forms and the mass of literature concerning them, it is now impossible for any single trained entomologist to master more than one order of insects—often not even that. If one worker is called upon to make identifications in all groups, it stands to reason his work will be inaccurate.

In this connection it is of interest to note that at the Third International Congress of Entomology, held at Zurich in 1925, the following resolution was passed: "The Congress considers it essential that the problems underlying Applied Entomology should be studied, and desires to impress upon Governments and Institutions concerned with investigations in Applied Entomology that time must be devoted to Systematic Entomology and fundamental research, such as Insect Physiology, Ecology and Pathology, since only by the study of these can insect control be placed on a sound basis."

INTERCHANGE OF WORKERS. International entomology should be benefitted by recommendations proposed by the League of Nations. The Fifth Assembly at its session of September 23rd, 1924, adopted a resolution inviting the adhering States to consider favourably applications for measures to facilitate interchanges of students and to grant travelling facilities to duly qualified teachers and scholars going abroad in the interest of science—further to found scholarships for the purposes indicated.

I have no information at this time as to the success attending such undertakings, but it is a pleasure to note that many countries have approved of the suggestions laid down and it is hoped that the science we are all specially interested in will in future years be advanced thereby.

I understand that the Department of Scientific and Industrial Research of Great Britain is of the opinion that great benefit would result from an exchange of scientific workers within the British Empire.

The report of the special sub-committee on Research of the recent Imperial Conference (1926) approved of the importance of providing facilities for the free interchange of officers between different services and for study leave to enable officers to keep in touch with the latest developments in their branch of science. It is obvious, of course, that an international arrangement for the exchange of research workers could be of even greater benefit.

These remarks are intended to refer particularly to governmental action regarding the interchange of workers. Most of us have knowledge of certain foundations and other organizations which have assisted. The International Education Board, for instance, has for its purpose the promotion and advancement of education, whether institutional or otherwise, throughout the world. Scholarships for overseas studies are awarded to young scientists of unusual promise and provision is made whereby financial aid may be given to institutions to assist outstanding research in the pure sciences and in agriculture.

ENTOMOLOGICAL FORECASTING. During recent years, as we all know, important advances have been made regarding the bionomics and habits of insects, particularly in those countries of the world where applied entomology is being developed. As a result of knowledge obtained, it has been possible to forecast outbreaks of white grubs, certain kinds of cutworms and other insects. For instance, in connection with outbreaks of the pale western cutworm, it has been demonstrated both in Alberta and Montana that the amount of rain falling in a given year has a distinct bearing on the abundance of the cutworms the following year. Such knowledge has been of great value in anticipating outbreaks and thus avoiding losses to grain crops. As regards white grubs the entomologist has been able to forecast injury to certain kinds of crops if grown on infested land. A method of forecasting dates when the different stages of the several generations of the codling moth may be expected to appear at any given place in a normal season, has been presented by Glenn of Illinois. Headlee, Shelford, and others have also been keenly interested in such investigations.

Detailed studies made by forest entomologists indicate that future outbreaks of the spruce budworm may be avoided by an improved system of forest management.

Other observations could be made but these brief references indicate the increasing importance attached to all research which will in any way

assist us in forecasting outbreaks of injurious insects. As Hyslop has said[1] the data obtained as a result of insect pest surveys should be of far reaching value in connection with entomological forecasting.

THE AMATEUR ENTOMOLOGIST. Is the rank and file of amateur entomologists increasing or decreasing? My observations would indicate that there has been a noticeable decrease. I hope I may be wrong in this, but if correct, what is responsible for this decrease? Is the economic entomologist encouraging the study of insects among those who possibly have not the same opportunities for research that he has? Personally, from what I have seen I rather doubt that he is. There is usually little time for the one engaged in problems of applied entomology to devote to the encouragement of some of those at least who have the aptitude, if directed, of contributing to scientific knowledge. Probably I should not say little time, because most of us I think could find some time to assist some one of our acquaintance who would welcome a guiding hand.

We all know that much of the splendid work of the past has been accomplished by amateur entomologists—men who loved the work for itself and not for any personal advantage. What can we do towards developing a future corps of amateur workers to fill the places of even such recently deceased authorities as Harrington, Wolley-Dod, Kearfott, Elwes, Casey,—to mention only a few.

At a meeting of the Royal Society of Canada, held in May, 1926, the question of encouraging natural history studies in the field among university students and others was discussed with committees appointed by the Royal Society, the Ottawa Field-Naturalists' Club and the Royal Canadian Institute. At this discussion in which several university professors, government officials and others participated, it was more or less openly admitted that perhaps one of the main reasons why students, particularly university students on this continent, did not seem to take the same interest in natural history studies in the field as did university students in Europe, was to be found in the curricula of the universities which in instances do not make provision for natural history studies in the field.

Perhaps we as an Association in co-operation with other organizations, such as our sister society, the Entomological Society of America, could do something to encourage a wider interest in many phases of research, particularly along lines of pure science.

Just one or two further remarks in closing. In the future welfare of the world the entomologist is undoubtedly destined to take a most

[1]U. S. Dep. Agric. Bull. 1103.

important part. The warfare against the insects is becoming more necessary year by year. Insect pests the world over are taking on new habits, developing into huge armies, and in fact are threatening the very foundations of our civilization. The members of this Association, the largest and most important of its kind in the whole world have a responsibility which I am glad to note they are not only recognizing but also imparting to other scientists, particularly to the younger students who are daily joining up for service. None of us can look to the future with certainty, but your President feels that, with the splendid interest in the success of all of this work which is developing and which we have personal evidence of at our annual meetings, victories of very great importance will be achieved in future years not so very far distant.

VICE-PRESIDENT C. J. DRAKE: The President's address is now open for discussion.

MR. A. F. BURGESS: Mr. President, I would like to say a few words of commendation in connection with this address of our President. I think it is an unusual address. I don't know when we have had a presidential address that has covered the field and the scope that this one has. I was particularly impressed with his introduction and opening remarks, where he paid tribute to Dr. Fletcher and to Dr. Howard. Probably many of the men here were not personally acquainted with Dr. Fletcher. Dr. Fletcher was one of those wonderful men whom it was a great privilege to come in contact with.

I certainly enjoyed the address and I am sure the other members did also.

MR. L. O. HOWARD: I want to endorse what Mr. Burgess has said. We have heard a very broad and remarkable address.

Referring to James Fletcher, this organization is largely the idea of Fletcher. He came down to Washington in the middle of August and we sat down and drafted that original Constitution. I don't think Fletcher, who was an optimist, ever for a moment visioned what this organization would grow into. If there is such a thing as the departed knowing what is going on here, then I think Fletcher today is enjoying listening to his old assistant President Gibson talking about entomology in such a way and saying such nice things about him.

I think President Gibson is to be heartily congratulated upon this address.

Adjournment: 12:45 p. m.

Thursday Morning Session December 30, 1926, 9:40 a. m.

The meeting was called to order at the above time by President Arthur Gibson.

PRESIDENT ARTHUR GIBSON: The first paper is by E. P. Felt.

INSECT PESTS NEWLY ESTABLISHED IN NEW YORK STATE

By E. P. FELT, *State Entomologist, Albany, N. Y.*

ABSTRACT

The recent appearance of three Japanese beetles in New York State, namely the Japanese beetle, *Popillia japonica* Newm., limited for a number of years to New Jersey, the Asiatic beetle, *Anomala orientalis* Waterh., and a Japanese Serica, *Aserica castanea* Arrow, is recorded. The grubs of all three are serious pests to sod, particularly lawns and golf greens. The Japanese beetles, so well known in New Jersey, are voracious feeders upon the foliage of a number of fruit and shade trees in particular. Earlier investigations in that state have shown that there are practical measures for the control of this insect in both larval and adult stages. There are also brief records, with an indication of the economic status of certain insects which have become established in the state during the past twenty-five years; as follows: Birch Leaf Miner, *Fenusa pumila* Klug.; Gipsy moth, *Porthetria dispar* Linn.; Chrysanthemum midge, *Diarthronomyia hypogea* Lw.; European corn borer, *Pyrausta nubilalis* Hubn.; Imported Pine Saw Fly, *Diprion simile* Hartig; The Apple and Thorn Skeletonizer, *Hemerophila pariana* Clerck; Oriental Peach Moth, *Laspeyresia molesta* Busck; European Hornet, *Vespa crabro* Linn.; European Pine Shoot Moth, *Evetria buoliana* Schiff.; Box Midge, *Monarthropalpus buxi* Labl.; European Earwig, *Forficula auricularia* Linn.; Spruce Bud Scale, *Physokermes piceae* Schr.; and European Elm Case Bearer, *Haplotilia limosipennella* Dup.

The appearance the past summer of considerable numbers of Japanese beetles, *Popillia japonica* Newm., in a number of localities in southern Westchester Co., on Staten Island and the western extremity of Long Island and the recognition of several infestations within this general area of two other Japanese beetles, namely the Oriental beetle, *Anomala orientalis* Waterh., and another species determined as *Aserica castanea* Arrow, and termed by us the Japanese Serica, very naturally aroused considerable interest in the local situation and has prompted this brief discussion.

It is fortunate for us in New York State and presumably for residents in other eastern states at least, that the Japanese beetle has for a number of years been limited to New Jersey and as a consequence the habits of the insect, its destructive possibilities and promising methods of control have been pretty thoroughly investigated. It must be conceded at the outset that spread of this insect can at best be retarded. There is no possibility of holding it at any given point. The experiences in New Jersey during the last few years indicate that certain methods, namely

judicious spraying with an arsenical and treatment with an emulsion for the destruction of the grubs would prevent serious injury. There is no reason why this insect should be allowed to become excessively abundant and destructive in the newly infested areas and we believe that good policy dictates emphasis upon possibilities of control in order to avoid serious damage. It is believed furthermore, that fairly satisfactory control will also aid materially in checking rapid spread of the insect. It is evident that the beetles have established themselves in some numbers at least fifty miles from previously known infested territory and with this in mind the insect may be expected to make somewhat rapid progress up the Hudson Valley, presumably being aided by favorable winds.

Infestations by the Asiatic beetle, *Anomala orientalis* Waterh., evidently of some years standing, are known to occur at White Plains, New Rochelle, Mt. Vernon, Westchester County, and at Jericho on Long Island. The adults are evidently much more local in habit than the Japanese beetles and not nearly so destructive to foliage though these feed to some extent upon blossoms, particularly roses. The grubs when numerous are very injurious to sod.

The Japanese Serica, *Aserica castanea* Arrow, although identified as occurring in this country only last summer, was found at Mt. Vernon, Westchester Co., in 1923, the species then being identified as *Serica paralella* Casey, and at that time was definitely associated with serious injury by the grubs to lawns and with material damage to smaller garden plants by the adults. This insect is widely distributed in Mt. Vernon, and also occurs in New Rochelle and more recently has been reported from Yonkers. There are also reports of this insect occurring in two northern New Jersey localities. The adults are somewhat voracious feeders and when abundant may cause considerable injury, especially to plants in small beds. It is difficult to estimate the economic status of this Japanese beetle and the Anomala mentioned above, though the known history of these two insects in this country suggests that they will be much less difficult to control than the much better known Japanese beetle of New Jersey fame.

It is interesting in this connection to turn to some other recently established insects in New York State in order to make comparisons.

The Birch Leaf Miner, *Fenusa pumila* Klug., was first recognized in this country in 1923 though it was not identified until Dr. Britton reared adults and sent them to Washington for determination. This miner affects the younger foliage of sprout birch in particular and when abundant may give a brownish cast to large areas, consequently its

presence and spread is easily determined. The insect now occurs throughout southern New England, Long Island, eastern New York and northern New Jersey, the small saw fly adults evidently drifting readily with the wind. It has occasioned some concern among nurserymen in the vicinity of New York City on account of its disfiguring the foliage of young trees. Generally speaking it cannot be considered a serious pest.

Gipsy moth, *Porthetria dispar* Linn. The general westward spread of this insect resulted in a few colonies being found in eastern NewYork State in 1922 although there had been infestations in earlier years, the latter due to commercial agencies. The threatened westward spread was prevented by the establishment in 1923, of a barrier zone extending from Long Island Sound northward through the Hudson and Champlain valleys to the international boundary. Since then there have been minor infestations found from year to year within this area. These have been cleaned up and the insect has been prevented from securing a permanent foothold in the forbidden area.

Chrysanthemum midge, *Diarthronomyia hypogea* Lw. This European midge was first detected in New York State about 1920, although it was found earlier in other section of the country. It is primarily a pest of cultivated chrysanthemums and when numerous causes serious damage. It is by all means advisable to prevent infestation by keeping the greenhouses cleared and admitting only plants which are free from the pest.

European corn borer, *Pyrausta nubilalis* Hubn. This insect was first found in New York State near Schenectady in the winter of 1919 and that fall an infestation was located in western New York. There has been a gradual and rapid spread particularly in the western area, so that at the present time about two-thirds of the arable land of the state is infested although commercial injury is practically restricted to a small area near Schenectady and to towns bordering Lake Erie or those adjacent thereto. It seems very probable that much of the spread in the western part of the state has been due to favorable wind currents, and a marked limitation of serious injuries to lowland near water suggests that material damage may not be general throughout the state. It is unsafe to depend upon this and growers in all infested areas are urged to adopt such modifications in handling the crop as will reduce the infestation to a minimum and prevent serious losses.

Imported Pine Saw Fly, *Diprion simile* Hartig. This saw fly appeared in New York State about 1918. It has caused some injury in the vicinity of New York City and is known to be established in the city of Rochester.

The Apple and Thorn Skeletonizer, *Hemerophila pariana* Clerck, was first recognized in this country in 1917, it being extremely abundant in

a limited area of Westchester County. There are three broods usually. The spread of this insect has been very rapid though not equal to that of the Birch Saw Fly mentioned above. Observations in 1922 and 1923 showed that the insect spread northward fifty to seventy-five miles each year, the infestation not only occurring in the orchard sections but also appearing even upon isolated apple trees here and there in rather densely wooded areas. The past season, 1926, it has been reported from central and western New York. The caterpillars feed upon the upper surface of the leaves and the insect is easily controlled by the usual spraying for orchard pests, consequently it is of little importance except in areas where spraying is not practiced.

The Oriental Peach Moth, *Laspeyresia molesta* Busck, was somewhat generally distributed on Long Island in 1916 and apparently did not spread northward and westward until the last few years. There have been no unquestioned records of the insect occurring any great distance from the vicinity of New York City, prior to the past season. It was then found and has been recorded from several Hudson Valley localities and from sections in western New York. The status of the insect as a pest in our section remains to be determined.

The European Hornet, *Vespa crabro* Linn., was recorded in the vicinity of New York City about 1914 and in 1918 had become established in southern Rensselaer County. The insect is not of much economic importance. The hornets damage shrubs by gnawing the bark from the branches, evidently for the purpose of obtaining material from which to construct nests. The past season, a specimen of lilac about 1½ inches in diameter showing a series of transverse scars, presumably made by these insects, came to our notice.

European Pine Shoot Moth, *Evetria buoliana* Schiff., was recognized in the vicinity of New York City in 1914, is now widely distributed throughout the state and causes some injury to ornamentals here and there, though the damage can hardly be considered as general and serious.

Box midge, *Monarthropalpus buxi* Labl. This insect appeared in the vicinity of New York City about 1913 and is now generally distributed in the residential areas where box is somewhat commonly grown. It multiplies enormously in some localities and causes such serious injury that estate owners have been compelled to spray for the insect or take the chances of serious damage to this valuable ornamental.

European Earwig, *Forficula auricularia* Linn., was reported from Aurora, near Buffalo, in 1912. Recent investigations indicate that the insect has held its own in that locality and presumably has become well

distributed throughout the village, though without having occasioned serious injury or annoyance.

The Spruce Bud Scale, *Physokermes piceae* Schr., was first identified in New York State in 1908. It is generally overlooked though it apparently causes material injury. It occurs as budlike clusters in the forks of the smaller branches and appears to be responsible for the death of twigs and in some cases produces a very unsightly condition.

European Elm Case Bearer, *Haplotilia limosipennella* Dup., was first brought to notice in New York State in 1901. It is somewhat generally distributed in the Hudson Valley at least and occasionally causes rather severe injury to European elms on Long Island. It is a local insect sometimes so abundant as to produce conditions suggestive at a distance of nearly complete skeletonizing by the Elm Leaf Beetle.

PRESIDENT ARTHUR GIBSON: The next paper is by C. H. Hadley.

THE STATUS OF SEVERAL IMPORTED PESTS IN PENNSYLVANIA

By C. H. HADLEY, *Harrisburg, Pa.*

(Paper not received in time for publication)

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by E. O. Essig.

SOME HIGHLIGHTS IN THE HISTORY OF THE DEVELOPMENT OF ENTOMOLOGY IN CALIFORNIA

By E. O. ESSIG, *University of California, Berkeley*

(Withdrawn for publication elsewhere)

PRESIDENT ARTHUR GIBSON: The next paper is by A. F. Burgess.

SOME PROBLEMS IN ECONOMIC ENTOMOLOGY

By A. F. BURGESS, *Bureau of Entomology, Melrose Highlands, Mass.*

ABSTRACT

The life of the Entomologist is crowded with problems and the larger the organization the more difficult becomes their proper solution. Under present conditions and probably for a long time in the future the satisfactory control of introduced pests that are destructive to

crops or seriously effect human welfare will require the best efforts of the economic entomologists. The public will demand and will require that remedies be found to relieve serious losses. Research must discover effective control measures that can be applied in a practical way or the work of the Entomologist is doomed to failure. So far as foreign pests that may at any time be brought to this country are concerned, every effort should be made to secure full information relative to their biology and habits before they arrive here. This is a field that has been given little attention. There is no question but that all information that can be secured along this line will prove extremely useful to American entomologists in the future.

The success of economic entomology in this country rests largely with the Entomologists themselves. Under present conditions most of the research and control are directed by government, state or provincial activities and largely on account of lack of uniformity of laws and regulations perfect cooperation is seldom secured. It cannot be too often repeated that "cooperation" means more than mere written agreements. It is a state of mind which will bring about mutual assistance in order that the problem at hand can be effectively solved. In the business world where profits are the major consideration results have been obtained by frequent consolidations and centralized control. The same results should be secured by the entomologists by wise leadership backed by effective cooperation.

This association is or should be the great clearing house where all entomologists can freely exchange views and arrive at a common understanding. Its development should be fashioned so that it will become increasingly effective in this respect, and the accomplishment of this purpose will tax the best efforts of the membership.

PRESIDENT ARTHUR GIBSON: Mr. Alan G. Dustan will read the next paper.

THE ARTIFICIAL CULTURE AND DISSEMINATION OF *ENTOMOPHTHORA SPHAEROSPERMA* FRES., A FUNGOUS PARASITE FOR THE CONTROL OF THE EUROPEAN APPLE SUCKER (*PSYLLIA MALI* SCHMIDB.)

By A. G. DUSTAN, *Entomological Branch, Ottawa, Canada*

The European Apple Sucker (*Psyllia mali* Schmidb.) was introduced into Nova Scotia some time prior to 1919, the year when it was first found in that province, and has become a serious pest in commercial apple orchards. It is attacked naturally by a fungus parasite, *Entomophthora sphaerosperma* Fres. which is present in varying

abundance in normal seasons. This disease has been grown artificially in cotton covered cages under favourable temperature and humidity conditions and material from this source spread successfully into suitable orchards throughout the infested districts.

The European apple sucker (*Psyllia mali* Schmidberger), long recognized as a serious pest of apples in many countries of Europe was discovered in the summer of 1919 in orchards surrounding Wolfville, Nova Scotia. This was the first record of the insect for America. Since the above mentioned date, however, the spread of the apple sucker has been rapid and it is now found in seven counties of Nova Scotia and two counties of New Brunswick, despite the fact that its progress was impeded by strict quarantine measures and by such natural barriers as wide stretches of water and extensive marshlands.

Life History and Economic Importance. The insect passes the winter in the egg stage, the eggs being laid in the autumn on the twigs of apple trees. The eggs are yellowish to orange in color, elongate-cylindrical and averaging .4 mm. in length. With the coming of spring the nymphs emerge, usually about the first week in May, and commence feeding on the bursting buds. They are much flattened dorso-ventrally and in the first four instars are orange to greenish-yellow in color. In the last stage they are pale green. Honeydew is secreted profusely in all instars. The nymphs feed at first on the opening buds but soon transfer their attention to the unfolding blossoms, clustering on the pedicles and more particularly in the axils of the flower stems. When approaching maturity they wander freely over the leaves, feeding as they go. They become fully grown in four to five weeks, the adults appearing early in June. The winged forms are pale green in color, very active and have the habit of springing into the air when disturbed. Egg laying does not commence until late August and continues through the autumn up to the time when heavy frosts are experienced.

In heavily infested orchards the insects are present in enormous numbers, over one hundred nymphs sometimes feeding in a single blossom cluster. Under such conditions severe blossom injury results, the insects sucking the juice from the flowers and causing them to turn brown and eventually die. In such orchards the set of fruit is materially reduced. A certain amount of foliage injury also takes place as a result of the feeding of the insects. Yellowing and browning of the leaves is frequently seen, the injured foliage falling prematurely. Such excessive feeding greatly weakens the vitality of the tree and results in a very much lighter crop of fruit. In the case of severe infestations, more

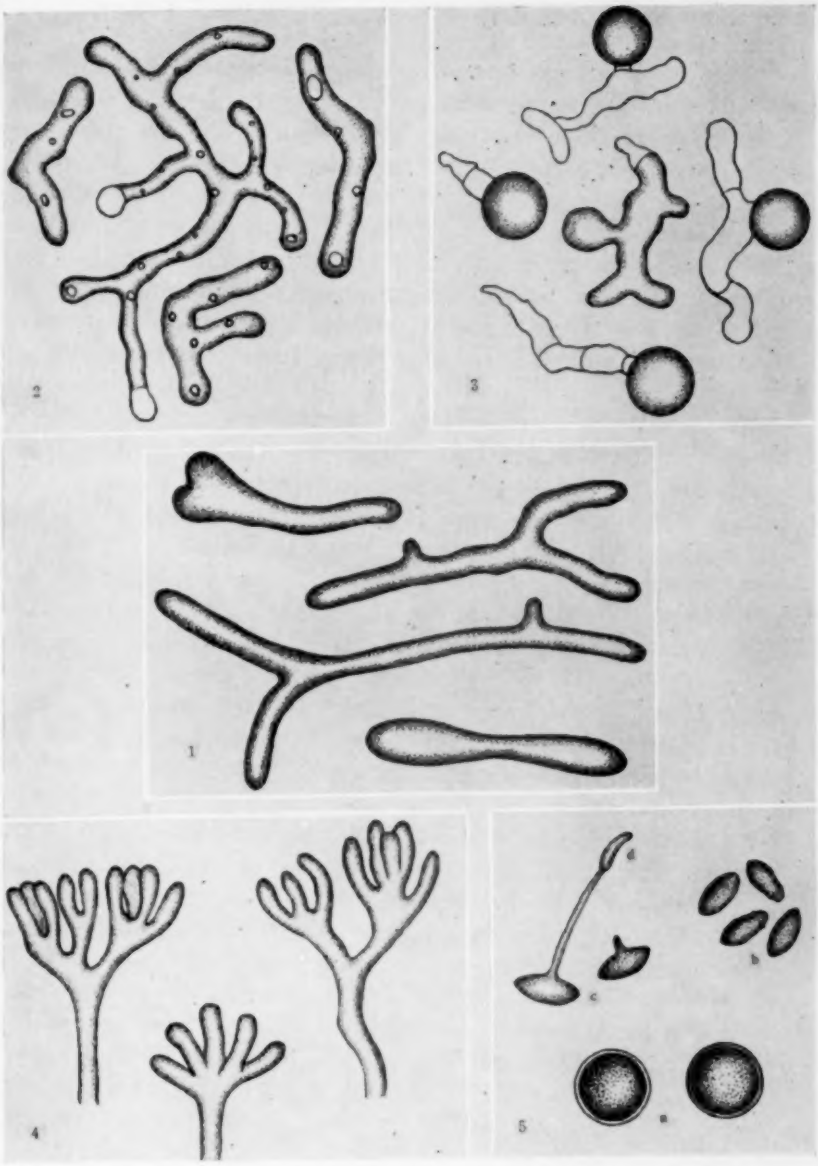
particularly when the bloom is fairly light, the whole crop may be destroyed.

NATURAL CONTROL FACTORS. Biological studies in connection with the apple sucker have shown that in the field the insect is reduced numerically to a limited extent in practically all stages. Insect parasites are wholly lacking but among the predators, birds, ants and spiders take an important toll of nymphs and adults. The economic control brought about by such factors is ineffective, however, compared to that exercised by the fungous parasite, *Entomophthora sphaerosperma* Fres., which in normal seasons plays an important part in checking the insect. This disease has been studied throughout a period of five years and has been shown to be of prime importance. It grows profusely in average years and under Nova Scotian conditions, lends itself readily to artificial culture and dispersal. This paper has been written with a view to outlining in some detail the methods used in culturing and disseminating this organism which have been gradually evolved from control experiments carried on in the field.

NOTES ON THE BIOLOGY OF *Entomophthora sphaerosperma* FRES. The fungus passes the winter in the resting spore stage, the spores being found in the bodies of dead insects adhering to the fallen leaves. In the late spring and early summer these germinate and in all probability give rise to conidia by means of which primary infection takes place. The process of germination has been watched in hanging drops of sterile water and although hyphae have been seen to grow out from the spores no conidia were formed. As primary infection takes place in the case of many other fungi in this way it seems reasonable to infer that a similar method is utilized by *Entomophthora sphaerosperma* particularly as germination of the resting spores has been actually observed.

In the orchard the nymphs are never attacked but after the organism has gained entrance to the body of the adults it develops, first, in the blood stream of the host. Many of the parasitized forms have been examined and it has been found that the fungus always grows by means of short mycelial threads that look like but fragments of mycelium (Plate I, fig. 1). They do not resemble the stout peculiarly shaped hyphal bodies that are found in many insects attacked by fungous parasites, and yet they are much shorter than the individual filaments which usually make up the ordinary fungus mycelium.

The fungus invades all parts of the host; the head, thorax and abdomen are readily attacked and mycelium may be found in the legs, even down as far as the tarsi. The organism continues to grow until all the internal structures of the host have been destroyed and, when the disease has



1, Mycelium from live adult showing type of threads in conidial stage. 2, Mycelium from dead adult prior to formation of resting spores. 3, Stages in the formation of resting spores. 4, Conidiophores. 5, Spores (a) Resting spores, (b) Conidia, (c) Germinating conidia, (d) Secondary conidium. (Original.) Magnification of all figures about 400 diameters.

fully developed, what was once an insect consists merely of a chitinous shell filled with fungous threads.

Shortly before this last stage in the development of the fungus is reached, the insects lose their power of locomotion and either drop to the ground or settle down on the underside of the leaves, preferably on those growing low down on the tree. The manner in which the conidiophores are produced from the mycelial filaments is not very clear, but after the fungous has reached its maximum growth hyphal threads commence to grow out through the integument. These probably are formed by the continued growth of the internal threads of mycelium. The majority of the hyphae emerge through the dorsum and eventually form the conidiophores, (Plate I, fig. 4) but some grow through the ventral sides and form rhizoids which, with the help of the beak and legs, fasten the dead insects to the leaves.

With the exception of a small area at the centre of the thorax, which is always bare, the hyphal threads grow profusely from all parts of the dorsum, spreading out laterally and in all directions but very rarely growing upward. As a result, the fungus, when mature and fully grown, appears as a dense, flat mat of mycelium spreading out radially from the dorsum of the insect which it completely covers, with the above mentioned exception. The mycelium varies greatly in color, being white or pale blue in most forms, but occasionally green specimens are met with and one or two red ones have been seen.

At first these threads are simple but as they elongate branches are formed at the tip and when fully grown each conidiophore bears at the apex a cluster of short, stout, irregular branches. Here the conidia are born (Plate I, fig. 5b), one being produced on each branch, whence they are shot off into the air to reinfect other insects. Successive generations of these summer spores may be produced in this manner throughout the whole season, so long as the temperature and relative humidity is favorable to growth and the host insects are present in sufficient numbers.

A short time after the fungus makes its appearance occasional insects are to be seen in the infested orchards which, although they show no external signs of the disease, yet are dead and attached to the underside of the leaves. Upon examination of one of these insects it is found to be filled with resting spores (Plate I, fig. 5a). These spores completely fill the body and can easily be discerned in the head, thorax and abdomen, including the legs.

Just what condition brings about the formation of resting spores has not been ascertained. Apparently the time of year has little to do with it, since they arise as readily in June as in October and appear almost

at the same time as the conidial stage. Probably a lowering of the temperature or a short period of dry weather at certain periods in the development of the organism produces the stimulation necessary for the formation of these spores.

It is interesting to note that the mycelium from which the resting spores are produced differs very considerably from the fungous threads that are present in the summer stage. In both cases the fungus grows in the form of short mycelial fragments but while these threads are smooth and regular preparatory to the formation of conidiophores, they are very rough and irregular in the resting spore stage (Plate I, fig. 2) Large knobs appear at various points along the threads and wart-like protuberances and swellings are found at their ends. These protuberances and swellings apparently give rise to the resting spores, for specimens have been examined in which the successive steps in their formation could be easily traced (Plate I, fig. 3). No sexual process was observed either prior to or during spore formation.

Methods Used in Artificially Spreading the Fungus. Realizing the importance of *Entomophthora sphaerosperma* as a control factor in the suppression of the apple sucker, a detailed study of the fungus was commenced in 1921 with a view to learning whether or not the disease lent itself to artificial dispersal and if it was possible to increase the scope of the epidemics each year by some such means.

Under natural conditions the spread of the fungus from one locality to ancther was too slow, when the time for such dispersal was often very limited, and it was hoped to accelerate the spread from orchard to orchard and from one locality to the next by some artificial method. This investigation was continued over a period of five years and at the end of that time it was evident that the fungus could be successfully spread in normal years and was a factor of prime importance in checking and controlling the insect.

A number of methods were tested with varying success but the following three, in the order listed, appear to have given the best results. (1) Where leaves bearing diseased adults were gathered in fungous-infected orchards and pinned to the under side of the foliage in the orchards to be infected. (2) Where flying adults were collected by means of nets in orchards where the disease was present and liberated in orchards at that time free from the fungus. This method was tested only after dissections of live insects from infected orchards had shown that fifteen per cent of them carried the disease in the blood stream. (3) Where young nursery trees planted in cotton covered cages were first infested

with disease-bearing insects and then transplanted into the orchards to be treated.

These methods were modified in different ways, in some cases the "plantings" were made in the morning and in others in the afternoon. In some orchards the insects were all liberated or pinned on a central tree while in others they were generally distributed through the orchard on a dozen trees or more. Although the differences were very slight it was thought that results were a little better when the insects were distributed on several trees in an orchard and when the "plantings" were made in the morning before the dew had dried.

Usually about a week after the diseased material had been placed in the orchard under experiment the fungus began to appear. Once started it spread very rapidly and within two or three weeks, providing the weather was favourable, was generally distributed throughout that orchard. As soon as the disease became firmly established, no further "plantings" were made, but another orchard was chosen, either in the same district or in another locality altogether, depending on whether the disease was being spread intensively in one section or started at widely separated points. These orchards served as foci of infestation for that particular district.

Regarding the number of "plantings" required to start an epidemic in any orchard this also varied greatly with the weather, with the type of orchard and the degree of infestation. As a rule two or three "plantings" sufficed to start an epidemic but sometimes more would have to be made. When the insects were introduced on leaves, two or three hundred were usually brought in at one time, while each "planting" of live insects, although hard to estimate, must have contained thousands of apple sucker adults. Once the disease gained a foothold in an orchard the insects themselves, by natural migration, assisted greatly in spreading the epidemic; not only to different parts of that orchard but from one orchard to the next.

After the work had been in progress a year or so it became evident that in normal seasons the disease appeared in the field under natural conditions too late to be as effective as it might have been had material for spreading been available earlier in the summer. This was due to the fact that in Nova Scotia the weather throughout May and June was too cold for the proper development of the disease.

Our studies had shown that fungus development and the outbreak of epidemics was dependent almost entirely on three factors, namely, correct relative humidity, a relatively high temperature and an abundance of the host insect. In the absence of any one of these three factors

it is impossible to produce an outbreak but given a suitable temperature and humidity in the presence of a large number of the insects an outbreak is assured.

Accordingly it was thought advisable to investigate the growing of this disease in cages in the early part of the summer where the temperature and humidity could be to some extent regulated and the number of insects increased at will.

At the commencement of the work three types of cages were tested, frame cages covered with plain factory cotton; similar cages in which the cotton was treated with parawax with a view to holding in the moisture and cold frame cages having wooden sides made of matched lumber and supplied with tightly fitting, removable glass tops under which was stretched a factory cotton screen to prevent the insects from escaping when the glass was removed. All cages measured 30 inches in length, 15 inches in width and 20 inches in height.

The cages covered in each case a number of apple seedlings on which the insects lived and fed and contained a supply of leaves saved from the previous year bearing an abundance of adults killed by the disease and filled with resting spores. The leaves were distributed on the ground at the base of the seedlings and served as the source of primary infection. These experiments were started as soon as the apple sucker adults appeared, usually about the first week in June.

By the use of thermographs and self registering thermometers it was learned that the highest temperature was reached in the waxed cages, the cold frame cages came next and the untreated factory cotton cage showed the least thermal increase. To give some idea of the increased temperature obtaining in these cages our records show that when the maximum temperature registered eighty degrees in the shade in the open, the waxed cage showed a maximum of one hundred and one degrees, the cold frame cage ninety-one and the cotton cage eighty-five. The minimum temperatures in the different cages did not show as much variation as the maximum temperatures, although the minimum in all cases stood six degrees higher than the prevailing temperatures at the same time in the open. It is interesting to note in this regard that the minimum in the cold frame cage never dropped quite as low as it did in the other two types of cages.

The relative humidity in the cages was increased by spraying the soil within the cages and the cages themselves a number of times each day with warm water depending on the weather prevailing. In this way it was possible to keep the relative humidity in the cotton, waxed and cold frame cages up to a maximum of ninety-one, ninety-three and nine-

ty-four degrees respectively over a period of weeks when the humidity in the open stood around eighty degrees.

From these brief notes it can be seen that in its ability to produce an increased temperature and relative humidity and to retain them throughout the twenty-four hours the cold frame cage was superior to all others and was adopted as the standard in our work.

As a result with this equipment it was found that epidemics could be started under cage conditions a month to six weeks earlier than ever took place in the orchards. Material from the small cages was transferred to large factory cotton cages where a more extensive supply of the fruiting stage of the fungus could be reared. These larger cages were built over moderate sized apple trees which in some cases were twenty feet or more in height and capable of supporting an immense insect population. Here the disease was cultivated and when favourable weather prevailed the fungus distributed into suitable orchards. These orchards then served as foci of infection and the disease spread from them into the surrounding country both naturally and by means of the artificial methods outlined earlier in this paper.

Our work in rearing and spreading this fungus has met with unexpected success, for it has been found a comparatively easy matter in years of average rainfall to grow the disease in cages and start epidemics in the field from that source. We feel that our success has been due largely to the climatic conditions prevailing in the Maritime Provinces, and more particularly to the rather heavy summer rainfall, the presence of fogs coming in off the ocean and the generally humid atmosphere experienced there. Also the fact that we were working with a single brooded insect which was liable to attack by a fungus parasite for a period of over four months, during some part of which time it was practically assured that optimum conditions would be met, had a very direct and important bearing on the problem.

MR. ALBERT HARTZELL: I would like to ask if that fungus has ever been grown in culture.

MR. ALAN G. DUSTAN: No. I have made several efforts of wide variety but have never been able to get the fungus to grow.

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by J. A. Manter.

CHARTS AND FORMS AS AIDS IN TEACHING ECONOMIC ENTOMOLOGY

By J. A. MANTER, *Connecticut Agricultural College, Storrs, Conn.*

The future entomologists are now receiving their initial training in our colleges and universities. The future development of the science of entomology depends largely upon the character of the education of these young men and women. It is doubtful that the teaching of entomology has reached as high a standard on the average as the teaching of some of the other sciences. Certainly there is much opportunity for improvement. The teachers in other subjects have organized themselves in order to bring about better teaching methods. It has been my hope that the problems of the teacher of entomology could have a larger place on the programs of this or some other organization. Perhaps one important reason why this has not occurred is because the teachers themselves have not brought their problems before these meetings in their papers. I know that the majority of our members are research workers and that all of us are keenly interested in the newer facts that they bring to these meetings. However, so many of our members teach, at least a part of their time, it would seem that they could spend at least one session in discussing pedagogical methods which would be of great importance in improving the teaching of entomology and result in the advancement of our science. These thoughts have given me courage to offer a small contribution in the hope that other teachers will give us the results of their experience.

I believe it necessary in teaching about insects to attack the problem from different angles, to secure different viewpoints, and to use varying methods. No one method will suffice. To study a series of insects one after the other, soon leads to great confusion on the part of the student. Many expedients have to be tried to keep the student out of this maze. The teacher of economic entomology does not have difficulty in securing plenty of subject matter in textbooks and bulletins. Because of this wealth of information there is little need for lectures. The very abundance of source material, however, makes it difficult for the student to pick out the essentials which he should learn. An attempt to overcome some of these and other difficulties, has led to the development and use of certain charts and forms at the Connecticut Agricultural College. Other colleges also have in use similar aids.

The "INSECT SHEET" has gone thru a process of evolution covering a period of several years. At first we had many more headings and subheadings than on the one in use at present. Many of these were elim-

inated from time to time to simplify the sheet, to emphasize the essentials, and to make the sheet more generally applicable. The following general information is needed to fill out one of these insect sheets; classification of the insect, plant, animal or material injured, characteristic type of injury, types of mouthparts and metamorphosis, description of stages, connected life history, economic importance, control measures, references, and drawings made from the insect and its work. I believe the use of the insect sheet aids the student in organizing his material, helps him in selecting the essentials, offers a chance for efficient reviewing, and is an aid to memory. There are some disadvantages in its use, such as, the ease with which one man may copy the work of another. The student must be shown that the filling out of the insect sheet is not the end in view but merely a means to an end,—simply a method of study.

Field work with living insects under natural conditions is very valuable in training the student. To see the insect at work and the injury that it is doing makes a more lasting impression than reading or hearing about them. Students enjoy these field excursions but often think of them as pleasant outings rather than opportunities to secure valuable instruction, thus getting little of lasting benefit from them. I have used the "INSECT FIELD REPORTS" as one means of holding the class to real work while on field trips. In order to complete one of these in the field, the student must make certain observations and deductions. The necessary observations have to do with the location and abundance of the insect, the plant attacked, the amount of injury, and descriptions of the injury and of those stages of the insect found. As the aim of the field work is to gain acquaintanceship with insects and their work, the field report asks the student to determine the characteristic markings of the insect so that he may identify it again and to observe the character of the injury that he may recognize it at any future time. The student will take better notice of the remarks and information given by the instructor and will observe more carefully the insects pointed out to him when he knows that he may be asked to fill out these field reports.

It is not easy for the student to learn the life histories of many insects without becoming more or less confused. He has a better chance of keeping these straight if he studies them by different methods and from different sources, such as; textbooks, reference bulletins, field studies, laboratory work, insect sheets, life cycle charts, and class discussions. To fill out the "LIFE CYCLE CHART" the student must determine the seasonal occurrence of the various stages of the insect. This chart has been made into a rubber stamp so that it can be reproduced where-

ever it can be used. The chart is circular in form, divided into sectors for the 12 months of the year. This arrangement gives a good idea of the cycle thru which the insect passes in the yearly cycle of months. It cannot be used without some additional data for insects requiring more than one year for their development and is not suitable for insects that have several generations a year. I think it better to indicate on the chart the periods of time during which the various stages of the insect are present rather than to attempt to chart the periods for an individual insect. Thus the student has the seasonal cycle for the species as a whole. An interesting exercise is to give some of these completed but unnamed charts to a class for identification. This leads to real concentration on the part of the student much as the solving of a puzzle. Both the insect sheet and the life cycle chart are useful when giving written quizzes.

The academic year does not include the best season for the studying of living insects but some species can be reared in the laboratory at any time of the year. Students should handle and rear as many insects as possible. It is difficult to have them appreciate the importance of making exact and complete data at regular intervals. An "INSECTARY RECORD" with appropriate captions for the students to use results in more exact scientific methods on their part.

The four forms and charts, illustrated by lantern slides, together with others, have been found useful and of aid to students altho it is realized that they are not without faults. The teacher needs to be constantly on the alert to take advantage of everything which will make his teaching more efficient, as all of us would like to see our profession reach a high standard along with the best

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Mr. L. S. McLaine expressed a wish that some of the teachers might express themselves as to whether they should like to have a symposium arranged on teaching methods at the next meeting.

MR. C. H. RICHARDSON: I believe this question of standardization of education in entomology is such an important one that this Association should have a committee appointed to deal with it. If we are to get young men adequately trained, it would seem only right that this Association should take some part in suggesting, not in a dictatorial spirit but in an instructive way, something toward the standardization of education in entomology. I believe if we had such a committee and if they would formulate some program, the more progressive colleges

and universities would be glad to avail themselves of their recommendations.

MR. H. T. FERNALD: Some years ago I was quite interested to ascertain the methods used by the teachers of this subject and I sent out a letter of inquiry to a large number of teachers at that time. The result coming from the answers was the conclusion on my part that there was no uniform movement; in fact, hardly two places had the same methods, and the teaching plan at that time was rather chaotic.

I made that statement, or something equivalent thereto, in print and shortly afterward I received a letter from Professor Comstock in which he stated that in his opinion that was one of the most promising things about entomology today. While I do not venture in any way to oppose Professor Comstock's opinion with my own, I think it, nevertheless, is indicative of a weakness in our system of teaching. There seems to be two main lines of training students in entomology today. One is the pedagogical view of the subject of entomology; the other is the consideration of the insect pests of different crops. Comstock's book, of course, is considered as the standard for the first type of treatment, and such books as Crosby's and Leonard's and others, which I do not need to mention, are wonderful examples of texts for use in the study of the insects affecting different crops.

I think that the determination of the line followed will prove finally to be determined not so much by the desire of the teacher as it will by the demands and needs of the students at the particular place where he teaches. In some places the presentation of entomology as a whole is the pedagogical, natural thing to start with, while in others the restricted aims and desires of the student body taking the subject will lead to a study of the pests of the crops rather as individual pests than as insects in themselves.

Yet, there are some ways, I believe, in which a greater uniformity of treatment can be obtained than we have at present, and for that reason I heartily approve of the suggestion which has just been made.

PRESIDENT ARTHUR GIBSON suggested that the matter of standardization in teaching entomology be referred to the Committee on Policy, which has a sub-committee considering such subjects.

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by William Robinson.

WATER BINDING CAPACITY OF COLLOIDS A DEFINITE FACTOR IN WINTER HARDINESS OF INSECTS[1]

By Wm. Robinson, *Division of Entomology, University of Minnesota*

Abstract

Colloids present in insect tissues and body liquids withdraw and bind free water under a falling temperature. Some of the properties are changed when water is bound and this protects the insect during the winter. There is a direct correlation between winter hardiness of insects and amount of water bound.

An injurious species may be very numerous in the summer and autumn, and proportionately scarce in the following spring. This is common knowledge to entomologists. The low temperature of winter is an effective means of natural control. It functions in a two-fold way,

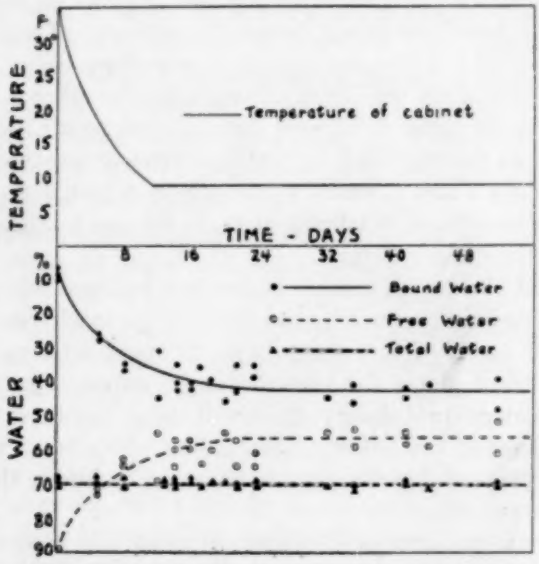

Fig. 1.—Effect of low temperature upon per cent of bound and free water with the moderately hardy *Callosamia promethea*.

for not only does it reduce the numbers of an injurious species year after year, even in an environment in which the species has become established, but it also restricts very largely the insect's continued spread. While their hosts go onward, the migration of many species of injurious insects is checked by the winter even when the summer is warm enough to per-

[1]Published with the approval of the director as paper No. 663 of the Journal series of the Minnesota Agricultural Experiment Station.

mit development of a life cycle. Why some species are unable to prep[illegible] themselves for certain low temperatures of winter and are ther[illegible]y killed outright if so exposed, while others are able to survive, is a problem about which not much is known.

In the field of colloid chemistry, however, there appears to be at least a partial solution of the problem, in the activities of colloidal particles. Colloidal behavior depends upon the presence of exceedingly minute particles, one-tenth to one one-thousandth of a micron in size, which occur in stupendous numbers in the protoplasm and in the intercellular liquids. Under a falling temperature those particles which have an attraction for water (because of surface forces) will begin to adsorb the water in which they are dispersed. Under certain conditions they will adsorb also salts or ions from solution. That is, the particles will take

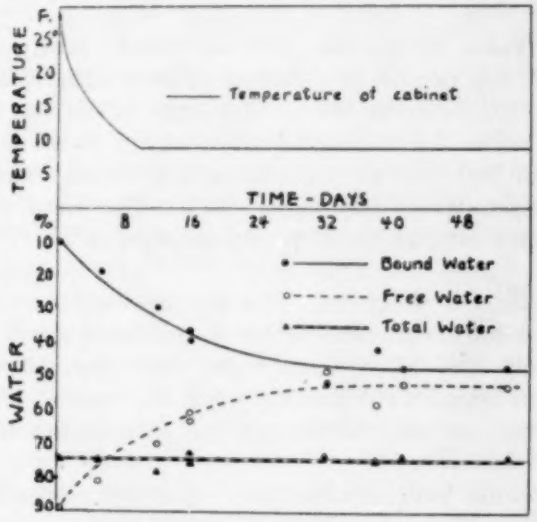

Fig. 2.—Effect of low temperature upon per cent of bound and free water with the hardy *Telea polyphemus*.

up water and bind it, not within but around themselves, as a film or shell. In this condition some of the properties of water are changed so that it ceases to function as ordinary free water. The shell may increase in thickness until it is greater than the diameter of the particle itself. Some of the innermost layers are held by the particle with a force that is almost inconceivable in biology.

There may be biological significance in the fact that some of the

properties of bound water are changed. There is not time here to discuss these except to mention that there is good evidence that bound water will not conduct electricity; will not freeze at five degrees below zero F. (—20°C.); will not dissolve sugars and other substances; and will undergo considerable compression. Free water is practically incompressible; the reason therefore that bound water can be compressed is, according to one theory, that it is oriented on the surfaces as layers of hydrogen and hydroxyl ions.

Newton and Gortner (1922), when working with hardy varieties of wheat, established the fact for plants that there is a direct correlation between winter hardiness and per cent of bound water; that is, the hardier the wheat the greater the amount of water the plant will bind at low temperatures. The writer is experimenting to determine if this phenomenon holds for animals, particularly cold blooded animals such as insects.

The hardy *Telea polyphemus*, the moderately hardy *Callosamia promethea*, and the non-hardy Granary Weevil, *Sitophilus granarius* were used for the preliminary tests. The pupae of the first two species are attached, within the cocoon, to the branches of the shrubs upon which the larvae feed, and are exposed to the lowest temperatures of winter in the regions where they occur. On the other hand, the Granary Weevils are rarely exposed to temperatures below 40°F. They cannot exist at 35°F. for more than a few days.

As the experiments progressed, it was seen that the phenomenon observed by Newton and Gortner for plants was holding true for insects. Under the stress of a falling temperature *polyphemus* and *promethea* began to gain in bound water and to lose in free water. The Granary Weevils, however, not only did not gain but actually lost bound water and gained in free water.

Low temperatures were obtained both naturally by placing some of the individuals outdoors during the autumn and winter and also artificially in refrigerating cabinets. Figures 1 and 2 show a fairly regular increase in bound water coincident with a fall in temperature. The cabinets were held at 8°F. which was just above the temperature which would cause the insects to freeze. Figures 3 and 4 show considerable fluctuations in temperature with a tendency for the bound water content to be similarly affected. *Promethea*, the moderately hardy species, lost bound water more quickly upon a rise in temperature than the hardier *polyphemus*. A scarcity of material at the time prevented more frequent determinations. Probably enough data are presented

to show fluctuations in per cent of bound water following changes in temperature.

In the non-hardy condition in which both species were started only 9% to 10% of bound water was found. This amount was increased during the experiment to approximately 42% for the moderately hardy *promethea* and to 48% to 52% for the hardier *polyphemus*. The latter species was able to bind more water and also to hold it more firmly

The total water content, it will be observed, remained practically constant throughout the experiments. The statement which is commonly made that the winter hardy condition is associated with low water content does not hold in this instance. However, winter hardiness is correlated with a low free water content; and possibly further studies will show this to be true in general.

The extent to which the non-hardy Granary Weevils reversed the process observed for the hardy species, is shown in Figure 5. In seven days at a temperature just below the freezing point of water, this species underwent a rapid degeneration in which it lost all but a mere fraction of its original bound water; and this was shortly followed by death.

Since bound water will not freeze at very low temperatures, the greater the quantity that can be converted into that form and the more rapidly it can be done, the greater is the protection afforded to that species. This is partly because of the expansion of water upon freezing and the consequent disruption of cells. There are other changes following freezing which time will not permit to discuss here. When adsorbed water undergoes compression, the colloidal particles and the bound water together occupy less space than the two separately. Therefore when free water freezes, as it does even in some hardy species, there will be more space for expansion without causing injury.

In making their determinations, Newton and Gortner used one hundred grams of wheat leaves and squeezed out the plant juice under a known pressure. In this way they established a correlation between pressure applied and amount of liquid expressed. This method, while suitable for plants, cannot very well be used for insects where a large mass of material is not available. The method used by the writer is based upon the fact that at —20°C. none of the bound water but all of the free water will be frozen; and also that as the free water freezes it will give off 80 calories of heat per cubic centimeter of volume. This heat is measured electrically with a potentiometer and thermocouple. The value for free water thus measured is subtracted from the total water content which is obtained by desiccation at 100°C., and the remainder is bound water. At this temperature all the bound water is not removed

and a higher drying temperature cannot safely be used, so that the bound water is a minimum determination.

During adsorption the body liquids of some species of insects become more concentrated. The lowering of the freezing point which occurs as a consequence is probably an advantage to those species, such as oak borers as noted by N. M. Payne (1926). However, depression of freezing

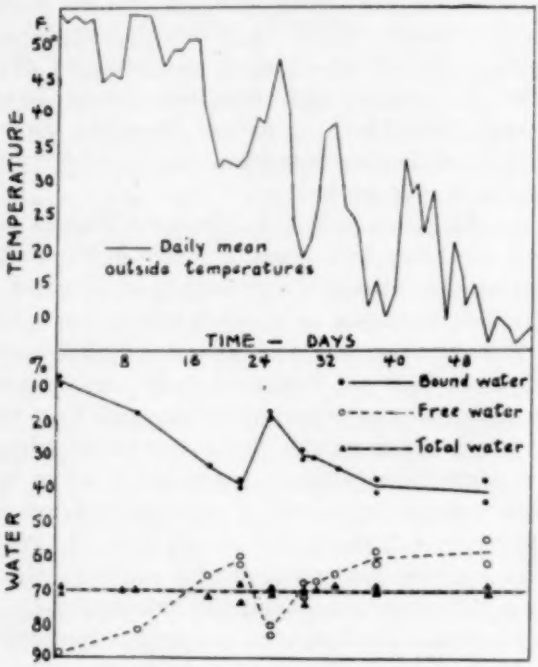

Fig. 3.—Effect of fluctuating outdoor temperatures upon per cent of bound and free water with the moderately hardy *Calloasmia promethea*.

point upon the approach of winter is apparently not as an essential factor in the hardening process and it does not always accompany adsorption. In the case of *polyphemus* and *promethea* used in the present experiments, the freezing point of the body liquids was not lowered, and remained at 27.5°F. (—2.5°C.) practically throughout the experiment, although 40% to 50% of the water was removed from solution. This is most likely due in part to the fact that under certain conditions adsorption will take up both water and salts, while under others the salts will be left in solution. If the electric charges on the colloidal particles and on the salts are similar they will repel each other, and adsorption of the

salts will be opposed. If the charges are dissimilar, the colloids and salts will be attracted and adsorption of the salts will be facilitated. Water and salts are adsorbed independently of each other and at different rates. Therefore depression of freezing point, when it occurs, does not necessarily indicate the extent to which hardening has progressed.

The tremendous force behind adsorption phenomena is derived from surface energy. Adsorption therefore is a physical process. Under a falling temperature a liquid with materials in solution or in suspension will become more viscous, as is well known. This alters interfacial

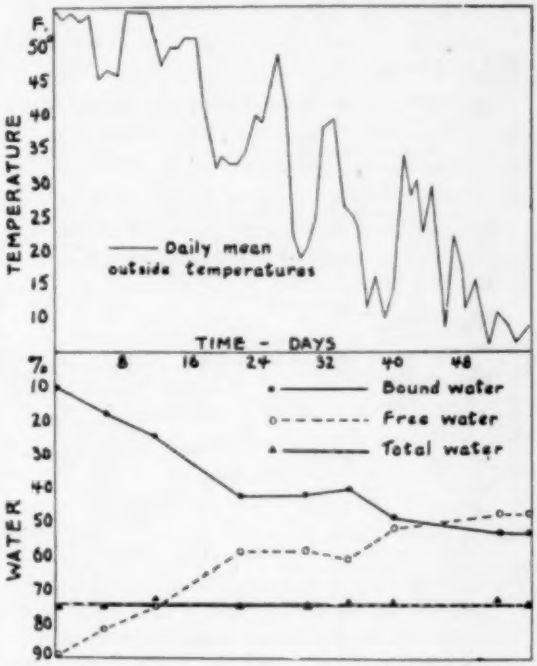

Fig. 4.—Effect of fluctuating outdoor temperatures upon per cent of bound and free water with the hardy *Telea polyphemus*.

tension between the colloidal particles and the liquid; and adsorption follows from the energy exerted to reduce this tension to a minimum. When equilibrium is established this activity will cease.

The per cent of water bound before equilibrium is reached is therefore an important phase of the problem of winter hardiness. For instance, with the hardy *polyphemus* this amount is between 48% and 52%, with the less hardy *promethea* it is between 40% and 42%, while with the

non-hardy Granary Weevils equilibrium was never reached. A rapid drop in bound water to practically nothing was terminated by death.

Accurate and complete data in low temperature studies are probably not obtained by determining the time and temperature necessary to kill an insect when it is exposed suddenly to any given low temperature. When an insect in the non-hardy summer condition is placed in a refrigerating cabinet representing winter conditions, that insect is exposed to an unnaturally abrupt change, and it may be killed before it can begin to protect itself. The study of winter hardiness may be extended to include:

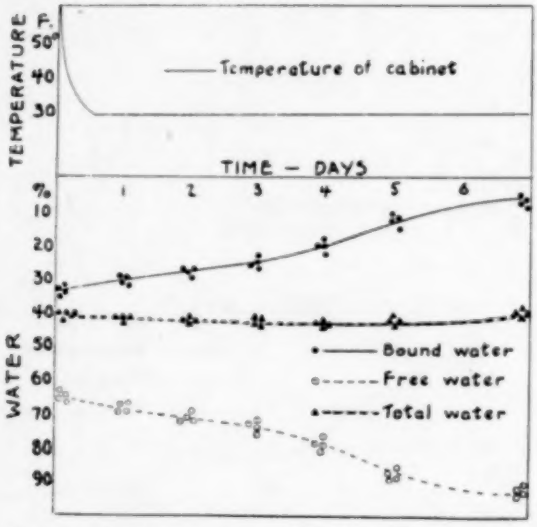

Fig. 5.—Showing reverse effect of a moderately low temperature upon the bound and free water content of the non-hardy *Silophilus granarius*

1. Water Binding Capacity. This measures per cent of water adsorbed and shows how completely and quickly the species is able to protect itself, if at all, against the adverse conditions of winter. The temperature at which adsorption begins and when it reaches equilibrium should be determined, and the rate at different temperatures.

2. Water Holding Capacity. This measures the ability of the insect to retain its bound water during fluctuations in temperature, and is a very important factor in winter hardiness; for it is believed that rapid changes in temperature during the winter and early spring cause high mortality among some species of insects.

Any given species, when exposed normally to low temperatures, will probably react in a regular and definite manner according to the specific characteristics of its colloids. These vary considerably in different species. The size of the particles alone plays an exceedingly important role in surface phenomena. Species may have definite, inherent limitations beyond which they cannot go. Low temperature is not the only factor involved in limiting distribution. However, if the temperature encountered is lower than can be tolerated by the species, then, by Liebig's law of minimum, that is the limiting factor, no matter how favorable other factors may be. In other words, "the chain is no stronger than its weakest link."

Many species have not yet reached the outer boundary of their migration. If studies were made of a number of economic insects such as the European Corn Borer, the Japanese Beetle, the Alfalfa Weevil, etc., and a correlation observed between low temperatures on the one hand and water binding and water holding capacity on the other, it seems reasonable to assume that a measure of winter hardiness could be made and corresponding limitations placed upon the continued spread of these or any other species.

Summary

Colloidal particles which occur in protoplasm and intercellular liquids will adsorb free water under a falling temperature. The water thus bound ceases largely to function as ordinary free water.

The direct correlation between winter hardiness of wheat plants and per cent of bound water observed by Newton and Gortner (1922) has been found to hold for cold-blooded animals such as insects. When a hardy, a moderately hardy and a non-hardy species were tested, the per cent of water adsorbed was found to be in direct proportion to their winter hardiness.

The biological significance and the advantages to the species of having their free water changed into the bound form upon the approach of winter is discussed; and the method of making the determinations is described.

Depression of freezing point of body liquids does not always accompany the hardening process. This is due in part to the sign of the electric charges on the particles and on the salts in solution.

Adsorption is a physical process, and is due to energy exerted to reduce interfacial tension which is affected by low temperatures. When equilibrium is established adsorption will cease. Per cent of water bound

by the insect before equilibrium is reached is of importance in the hardening process.

Suggestion of including studies of water binding and water holding capacities in low temperature work is made.

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PRESIDENT ARTHUR GIBSON: The next paper is by F. L. Campbell.

NOTES ON SILKWORM NUTRITION

By F. L. CAMPBELL, *New York University*

ABSTRACT

Since nutritive liquids can be fed quantitatively to certain insects, it should be possible to determine the essential food components of an insect diet and their relative proportions. As a qualitative example of this method it is shown that cow's milk contains some food which the silkworm can utilize for maintenance. This method and the doubled leaf method described in this paper may also help to explain the specificity of food plants among leaf-eating insects.

Three possible explanations may be offered for the tendency of many leaf-eating insects to restrict their diet to the foliage of one or of a few species of plants: First, such an exact coadaptation may exist between the feeding mechanism of the insect and the acceptable foliage that it may be mechanically impossible for the insect to feed on leaves differing structurally from those of the chosen food plant. Second, the sense organs controlling the feeding mechanism may be so delicately adjusted to stimuli from the acceptable foliage that other leaves may not supply

stimuli requisite for setting the feeding mechanism in action; or, if the insect can attempt to eat, the repellent taste of the unusual foliage may prevent further feeding. Third, if foliage not normally consumed is eaten, it may lack the proper components for growth or maintenance, may not be sufficiently digested, or may even exert a toxic effect.

Some preliminary experiments were performed on the silkworm, *Bombyx mori*, to test the foregoing possibilities.

Since the silkworm in the latter instars feeds on the margin of the mulberry leaf, leaf thickness might be one of the physical factors limiting the food plants of this insect, the average thickness of the mulberry leaf being less than that of many other species. This possibility was tested by the following experiment: Two flat portions of a mulberry leaf were cut out, moistened with water, and pressed together. The interfacial film of water held the leaf portions firmly together during the time of the experiment. The edges of the doubled leaf were trimmed with scissors so as to leave a sharp, even margin. A number of these doubled leaves were prepared and were offered to fourth instar silkworms. The larvae consumed the leaves along the margin in the usual manner, proving in this case that double leaf thickness is not a barrier to feeding.

The doubled leaf method also offers an opportunity for testing the effect on feeding of stimuli from leaves. When one-half of the doubled leaf consists of mulberry and the other of a different species, the silkworm should eat both leaves simultaneously, if failure to eat the foreign leaf alone is due merely to the lack of the requisite stimuli from it. Ailanthus leaves, which have approximately the same thickness, surface, and flexibility as mulberry leaves, were used as the foreign member of the pair. The silkworms did not attempt to eat ailanthus leaves alone, but when ailanthus was combined with mulberry, the larvae did attack the double margin, being repelled at every attempt, apparently by the taste of ailanthus.

Since the silkworm will not eat many leaves, such as ailanthus, it is difficult if not impossible to test their food value. But one cannot help feeling that if it were possible to introduce foreign foliage into the alimentary tract, some of these species of leaves might maintain the life of the insect. If solids, such as leaf particles, cannot be introduced into the alimentary tract artificially, at least it is possible to introduce liquids. When a drop of an approximately neutral fluid is placed on the mouthparts of a silkworm, the drop is usually imbibed. The nutritive liquid most easily obtained is cow's milk. Consequently milk was used for the initial experiments, for it was thought that if a liquid so foreign to the nutrition of a phytophagous insect should prove adequate in any

degree for the maintenance of its life, one might hope to prepare a more suitable nutritive liquid.

The survival time of five milk-fed silkworms of the fourth instar was compared with that of starved controls. As much milk as a larva would take was administered at each feeding period, the worms being fed from two to six times a day. In about 24 hours after the beginning of the experiment the alimentary tract of the milk-fed worms was cleared of leaf fragments, and the worms appeared translucent when observed before a lamp. The excrement at this stage consisted of soft, curdy pellets of milk solids, showing that the intestinal juices had some effect on the milk. The larvae continued to drink milk freely and crawled about normally. Four days after the beginning of the experiment the starved controls were dead. The milk-fed worms were in good condition at this time, drinking avidly, passing milk-solid pellets, and crawling normally, but no growth had taken place for the worms had not gained weight,—nor had they lost weight. One week after the beginning of the experiment the milk-fed worms seemed slightly weaker and milk began to issue from the anus with the pellets; but the worms still drank avidly. The larvae lived three days longer becoming weaker and losing weight slightly but drinking milk to the last.

The milk-fed larvae lived a week longer than the starved controls. That this greater survival period was not due merely to dehydration of the controls was shown by a subsequent experiment in which the length of life of milk-fed worms was compared with that of water-fed controls. This experiment was continued only long enough to show that the milk-fed worms were in good condition after the water-fed worms had died.

These results seem to show that the silkworm can obtain some nutriment for maintenance from cow's milk. Further use of this method for studying insect nutrition might lead to a qualitative and even to a quantitative knowledge of food components essential for the growth and maintenance of certain insects, and incidentally might contribute to a better understanding of the reasons for the specificity of food plants among phytophagous insects.

MR. N. E. MCINDOO: If he wanted those silkworms to eat those apple leaves, he could have fooled them by dipping them in the juice of the mulberry leaves. We carried on a number of experiments, using apple leaves, peach leaves and plum leaves, and several others. It was very easy to get the silkworms to eat the leaves that they don't ordinarily eat, by wetting them in the mulberry juice.

PRESIDENT ARTHUR GIBSON: The next is a paper by Miss Grace H. Griswold.

OBSERVATIONS ON THE BIOLOGY OF A NEW GERANIUM APHID (*MACROSIPHUM CORNELLI* PATCH)

By GRACE H. GRISWOLD, *Cornell University*

ABSTRACT

The host plants of the aphid, the number of instars, the length of the reproductive period and the number of young produced are discussed. Notes are given on the habits of four hymenopterous parasites reared from the aphid, namely, a braconid, *Praon simulans* and three chalcids, *Aphelinus jucundus*, *A. semiflavus* and *Aphidencyrtus inquisitor*. Control measures are suggested.

During the spring of 1925 a geranium which was badly infested with aphids was brought to the Insectary. Specimens of the insects were sent to Dr. Edith M. Patch for identification. She found them to be closely related to the European geranium aphid, *Macrosiphum pelargonii* (Kalt.). They differ from this species, however, in the number of sensoria on the third antennal segment of the wingless female. Dr. Patch has therefore (1926: 334) described them as a new species under the name *Macrosiphum cornelli*. According to Theobald (1926: 125) in *Macrosiphum pelargonii* the sensoria on III of the antenna of the wingless female range from 1 to 5, whereas in *Macrosiphum cornelli* they average many more, about 15 generally.

HOST PLANTS. This aphid has as its host plants in the greenhouse several species of the genus Pelargonium. Although the insect has been in the greenhouse constantly in great numbers during the past twenty months it has never been found attacking any other genus of plants. In the list of geraniums here given[1] the species are arranged in accordance with what seems to be the preference of the aphid: *Pelargonium quercifolium* hybrid, *P. odoratissimum*, *P. domesticum*, *P. graveolens*, *P. peltatum* and *P. radula*.

Plants of the commonest of all geraniums, *Pelargonium hortorum* have always been in the greenhouse but the aphids have never been found to feed upon them.

FEEDING HABITS. The aphids are found principally on the under surface of the leaves where they feed along the midrib and other large veins. They also cluster on the petioles and on the stems of new growth.

LIFE HISTORY. During the time that it has been under observation the aphid has reproduced only parthenogenetically and no sexual

[1]Determined through the courtesy of Lua A. Minns of the Department of Floriculture and Ornamental Horticulture at Cornell University.

forms have been found. Females give birth to living young at all times of year. Life history studies show that there are four molts and therefore five instars. Under ordinary greenhouse conditions of temperature and humidity the aphid begins to produce young within about twenty-four hours after becoming adult. The main reproductive period lasts about two weeks but may be extended considerably. The number of young produced each day is reduced, however, and often several days may elapse without any being born. Then the female may give birth to a single individual and again two or three days will pass. This sort of thing may go on for a week or two. Finally reproduction stops entirely but the aphid may continue to live for some time. In one instance in the present study an individual lived 22 days after reproduction had ceased. The entire life of this particular aphid extended over a period of 59 days, which was slightly longer than that of any of the other aphids under observation.

Because of a shortage of host material it was not possible to rear many aphids on individual plants. Some other method, therefore, had to be devised. Geranium leaves will keep fresh for days in water and on leaves so kept it was possible to rear a long series of insects in individual cages. Aphids so reared never lacked for moisture and often remained for days apparently in exactly the same spot on the leaf. It was found, however, that aphids reared in this manner matured more rapidly and seem to have produced a larger number of young than did those that developed on growing plants. Insects reared on leaves in water matured in from 9 to 11 days while those that developed on growing plants required from 11 to 13 days. The maximum number of young produced by 29 aphids kept on leaves in water was 80, the minimum 8, and the average 35.65. So few aphids were reared on growing plants through their entire reproductive period that it is not possible to make accurate comparisons. The maximum number of young produced by 9 individuals so reared was 34, the minimum 4, and the average 21.88. It is planned to propagate sufficient material so that it will be possible to conduct further rearing experiments on growing plants. In this way additional data can be obtained under what are probably more normal conditions for the insect.

PARASITES. In the present study four species of hymenopterous parasites[2] have been reared from this aphid:—the braconid *Praon simulans* Prov. and three chalcids; *Aphelinus jucundus* Gahan, *Aphelinus semiflavus* How. and *Aphidencyrtus inquisitor* (How.).

[2]Determined through the courtesy of A. B. Gahan of the U. S. Bureau of Entomology.

Praon simulans, when its larval growth is practically complete, leaves the aphid through a slit cut in its ventral surface (Wheeler 1923: 25). It then spins a cocoon beneath the body of its host, thus raising the whitened shell of the aphid from the plant surface. In this cocoon pupation of the parasite takes place.

Aphelinus jucundus was probably brought into the Insectary greenhouse with the aphid for this parasite has been constantly present ever since and hundreds of specimens have been reared. This chalcid is evidently parthenogenetic for no males have yet been encountered. Life history studies now going on show it to be a primary parasite and that the life cycle requires about four weeks. When the larva of the Aphelinus has attained its growth and its feces have been voided, the aphid turns black and within this blackened shell pupation of the parasite occurs.

Aphelinus semiflavus is probably also a primary parasite. The biology of this chalcid was carefully studied by Hartley (1922: 209–236).

Aphidencyrtus inquisitor, on the other hand, appears to be a hyperparasite, though the final proof of this is still lacking. Large numbers of geranium aphids from which this parasite has been reared have been dissected. In every case some evidence of other occupancy of the host has been found. In a few instances actual remains of *Aphelinus jucundus* pupae or adults have been present, but generally the principal evidence has consisted in the finding of two kinds of feces. Dissection of geranium aphids from which specimens of *Aphelinus jucundus* have emerged show the excrement to be in the form of flat black plates. In aphids from which the Aphidencyrtus has emerged, however, are found not only these same flat black plates, but also small orange-colored pellets of excrement.

Rearing experiments were attempted to prove the point. Several specimens of both sexes of this parasite were introduced into a cage of parasite free aphids but without success. At the same time and in exactly the same manner specimens of the Aphelinus were introduced into a cage of parasite free aphids. About a month later large numbers of these chalcids emerged. During February, 1926, the Aphidencyrtus suddenly disappeared from the greenhouse and not a specimen has appeared there since. A short time ago several individuals of both sexes were reared from aphids taken in the greenhouse of the Department of Plant Breeding. These were allowed to mate and were then liberated at the Insectary. It is hoped that they will again become established. Dr. L. O. Howard has suggested the advisability of dissecting living

material to definitely settle the question of hyperparasitism. If sufficient individuals become available this will be done.

Control

In a greenhouse the geranium aphid can be easily controlled by fumigation with calcium cyanide using ¼ ounce to every 1,000 cubic feet of space.

Where fumigation is not feasible nicotine sulfate may be used at the rate of 1 teaspoonful to 1 gallon of water. To this 1 ounce of ivory soap should be added. This material may be applied as a spray or the plants may be dipped in it.

Probably the simplest method of control other than fumigation is the use of a 2% free nicotine dust. Within five minutes after the dust has been applied aphids may be seen dropping from the plants. Experiments at the Insectary have shown that from 90 to 100 per cent control can be secured by the use of this dust.

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President Arthur Gibson: The next paper is by Miss Bessie M. Broadbent.

FURTHER OBSERVATIONS ON THE LIFE HISTORY, HABITS, AND CONTROL OF THE NARCISSUS BULB FLY, *MERODON EQUESTRIS*, WITH DATA ON THE EFFECTS OF CARBON DISULPHIDE FUMIGATION ON THREE BULB PESTS

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Abstract

Since November 1925, considerable progress has been made in working out details of the biology of the Narcissus bulb fly, *Merodon equestris* Fab., under outdoor conditions at Washington, D. C. It was found that the larval stage lasted about 10 months. Pupation took place from March 25 to April 17, 1926, and the pupal stage lasted 5 to 7 weeks. Flies emerged from May 8 to 22. Maximum longevity of the flies was 4 weeks, the average length of life being 16 or 17 days. Egg laying capacity was nearly 100 eggs per female fly. Eggs hatched in 10 to 14 days, the average

being 12. Larvae grew most rapidly during the first two months. Detailed information on various phases of the life history is presented in tabular form. Notes showing severity of infestation of imported King Alfred narcissus bulbs with larvae of *M. equestris*, *E. strigatus*, and *R. hyacinthi* are given.

Preliminary data is presented in tabular form showing the effects of CS_2 fumigation, under normal atmospheric pressure, on larvae of both bulb flies and on the bulb mite, as well as on the subsequent growth and flowering of the bulbs at dosages ranging from 10 to 30 pounds per 1000 cu. ft. with exposures lasting 2, 12, and 23½ hours. The results proved quite decisive and serve to suggest the range of effectiveness of this chemical as a bulb fumigant. The 10 lb. dosage with a 2 hr. exposure was equally ineffective under a 27-inch vacuum and under normal atmospheric pressure, but neither treatment injured the growth and flowering of the bulbs as compared with that of the untreated "checks." Dosages of from 10 to 30 lbs. with exposures of 23½ hrs. gave 100 per cent control of both species of larvae and from 90 to 99.4 per cent control of the bulb mites. Dosages of 20 to 30 lbs. with a 23½ hr. exposure proved fatal to the bulbs and caused a characteristic brownish discoloration of the basal plate. These results suggest the possibility of finding a range of lower dosages and shorter exposures that will kill these pests without injuring the bulbs.

In an effort to furnish more definite information about the life history, habits, and control of the Narcissus bulb fly, *Merodon equestris* Fab., under American conditions than was already available in literature, the Bureau of Entomology during the summer of 1924 undertook to make a study of this insect. Owing to the limited supply of infested bulbs that was available for this purpose, it was impossible at that time to do more than work out a satisfactory method of rearing the flies, and to make general observations on their seasonal life history and habits. These preliminary observations were published by Dr. C. A. Weigel.[1]

The Narcissus bulb quarantine which became effective on January 1, 1926, has tended to compel recognition of the importance of preventing the permanent establishment of this bulb fly in commercial bulb plantings, and has emphasized the need for more accurate information about its behavior. For these reasons the Bureau has not only established a Bulb Insects Field Station at Santa Cruz, California, in charge of C. F. Doucette, who is investigating this problem under the climatic conditions that prevail in the Pacific Coast bulb plantings, but has also continued the investigations which were being made under eastern conditions at Washington, D. C.

During the past year the writer, under the direction of Dr. Weigel, and with the assistance of A. T. Grimes, attempted to work out in

[1]Weigel, C. A. Observations on the life history of the Narcissus or Daffodil fly, *Merodon equestris* Fab. Journal of Economic Entomology, Vol. 19, No. 3, pp. 497–501. June, 1926.

more detail various phases of the life history of the bulb fly under outdoor conditions in the East. The results of these studies, together with the experiments with carbon disulphide fumigation for the control of both bulb flies and the bulb mites, which are discussed under "Control," are presented herein. The purpose of this paper is primarily to make this information available to other investigators in the same field. Technical descriptions of the various stages are purposely omitted, and for the sake of brevity much of the data recorded from different observations is presented in tabular form. The life history records are discussed in chronological order to avoid confusing the development of different broods of the flies.

Source of Larval Specimens. In November 1925, many nearly full-grown larvae from two different sources were available to continue this investigation. One lot consisted of a few larvae reared from stock obtained from the Pacific Coast in August 1924 that had previously been used in the life history studies during 1925. The other and principal source of larval material was a supply of heavily infested King Alfred Narcissus bulbs selected from a shipment that had recently been imported from Holland, and was submitted to this office for experimental use.

The reared larvae were infesting bulbs planted in bulb pans sunk in sand in large screened boxes in the cold frame, and were left undisturbed until the adult flies had emerged from them the following spring. A total of 19 flies emerged from this material between the dates of May 8 and 22, 1926. Most of the bulbs from Holland that were infested by *Merodon* larvae were used in the carbon disulphide fumigation experiments. Enough were salvaged, however, so that it was possible to rear more than 100 flies from them.

Rearing Methods. The rearing methods used were very similar to those used the previous year. Pans or flats containing bulbs infested with the *Merodon* larvae were left undisturbed in a cold frame over winter, i. e., from December until March 25, where they were covered by a layer of ashes several inches deep to protect them from extreme cold.

In the spring these flats were uncovered and then screened to prevent the possible escape of flies. From the middle of March until late in April these infested bulbs were examined daily to determine the exact date when pupation took place. The pupae were removed and placed near the surface of the soil in small pots. These pots were then sunk in boxes of sand to keep them from drying out too much. The boxes were then screened, and placed in a screen insectary, 9′ x 6′ x 6′, located near

the greenhouse. As soon as these flies emerged, they were released in insect cages measuring 12″ x 19″ x 21″ which had screen on five sides, and were mounted on oil cups to keep the small red ant, *Monomorium pharaonis* L., from attacking the flies. Pots of bulbs exposed to egg laying by these flies were removed daily, or more often if necessary, in order to get the exact dates of oviposition. After the larvae had hatched from these eggs, the pots of bulbs were then sunk in boxes of sand in the cold frame and were examined at intervals during the summer to get data on larval development. Since these specimens were reared entirely under outdoor conditions, it is believed that they approximate fairly closely the development of the flies under climatic conditions that are likely to prevail in the Eastern bulb plantings.

Seasonal History. Briefly outlined, the seasonal history of the fly from May 1925 to November 1926 has been as follows: Eggs were deposited during the latter part of May and early in June from which larvae hatched and began feeding in June. These larvae continued to feed in the bulbs for many months, and remained in them as larvae during the winter. None of them transformed to pupae earlier than March 25, 1926, after spending approximately ten months in the larval stage. The pupal period lasted for from five to seven weeks, and averaged about six weeks. The flies began to emerge on May 8, and continued to appear daily until May 20, thus completing a one-year life cycle of development from egg to adult.

These flies laid eggs from May 14 to June 7, from which larvae hatched within two weeks, or during the latter part of May and early in June. These larvae still remain in the bulbs in November, although some of them are now about six months old and appear to be full grown.

The evidence thus far obtained seems to indicate that this species is able to survive the winter under outdoor conditions in the East and breed continuously from year to year.

Life History and Habits

Larval Period. The larval period lasted about ten months according to the records obtained from larvae that hatched from eggs laid late in May 1925. These newly hatched larvae began feeding in the bulbs early in June, and continued to feed during the summer. They remained in the bulbs all winter without changing to pupae, and in fact they did not begin to pupate earlier than March 25, 1926. That most of them had already pupated by April 10, however, is shown by the following records:

57 larvae pupated from March 25 to 31;

41 pupated from April 1 to 10; and
8 pupated from April 11 to 17.

PUPAL PERIOD. The pupal period during the spring of 1926 was found to vary from 33 to 50 days, based on exact records for 66 individuals, and these observations are presented in Table 1. The average time was about 43 days, and the dates of pupation ranged from March 25 to April 17. The duration of the pupal stage was evidently determined mainly by the prevailing temperatures. For example, the longest period noted was from March 26 to May 15, and the shortest was from April 15 to May 18, the time decreasing as the weather grew warmer. Two flies that had pupated on April 9 and 17 respectively, emerged on the same day, May 20, a difference of eight days. The mean soil temperature during the interval from March 30 to April 30, inclusive, was 52.5° F., the maximum being 67° and the minimum 43°.

The pupa usually occupies a nearly vertical or somewhat slanting position with its head about level with the surface of the soil so that it is in contact with the air. In one instance it happened that a pupa was buried deeper, and the fly successfully emerged through about half an inch of soil. Several other pupae that were intentionally buried under a layer of soil 3 inches deep, failed to get out of their pupal shells and died there without emerging or reaching the surface. One pupa in a flat that was not disturbed from November 1925, until May 27, 1926, was found beneath the surface where it had pupated. Its respiratory cornua had failed to push through the puparium, and it had failed to develop into a fly.

Most of the larval specimens under observation had to be disturbed frequently during March and April to find out when they were ready to pupate. As a check on the seasonal development of the flies under normal field conditions three flats, each of which contained about 20 infested bulbs, were left undisturbed from December until May 20. The flies began to emerge from them on May 10, and on May 20 when the bulbs were cut up, and the soil sifted, a total of 32 flies had emerged. About 10 pupae failed to emerge and three of them were dead or decayed. These results indicate that there was no significant difference in the date of emergence of the flies when the larvae had been disturbed frequently, and when they had not been disturbed at all.

The pair of anterior respiratory cornua which appear on the pupal head were not observed to push through the wall of the puparium and become visible externally until from 9 to 14 days after the larva had pupated. (These observations are presented in Table 2.) These

TABLE 1. DURATION OF PUPAL PERIOD OF *Merodon equestris* IN 1926, BASED ON DEFINITE RECORDS FOR 66 INDIVIDUALS, SHOWING HOUR OF EMERGENCE OF FLIES

Number of Flies		Date of		Hour of	Duration of
Female	Male	Pupation 1926	Emergence 1926	emergence A. M.	pupal period Days
1		Apr. 15	May 18	7:25	33
	1	17	20	12:20*	33
1		15	19	7:00	34
1	2	1	9	8:00	39
2		8	17	7:35	39
	1	9	18	7:25	39
1	1	1	10	8:00	40
1	1	5	15	7:40	40
	2	8	18	7:45	40
	1	1	12	8:45	41
	1	2	13	9:15	41
1		4	15	7:35	41
1	1	6	17	6:40	41
1	1	6	17	7:25	41
1		8	19	9:30	41
1		9	20	7:40	41
2		4	16	3:00*	42
1	1	6	18	7:25	42
	1	Mar. 29	11	10:00	43
1		Apr. 1	14	8:00	43
1		4	17	7:00	43
2		4	17	8:05	43
1		5	18	4:00*	43
1		Mar. 27	10	8:15	44
1		29	12	7:45	44
	1	29	12	10:30	44
1	1	Apr. 4	18	7:10	44
1		Mar. 27	11	8:00	45
	1	27	11	10:45	45
1	2	29	13	7:50	45
1	1	30	14	8:50	45
1		27	12	7:45	46
2		29	14	7:45	46
2	1	29	14	8:40	46
	1	30	15	7:35	46
1	1	27	13	7:50	47
	1	29	15	7:30	47
	1	25	12	8:15	48
2	1	27	14	7:45	48
1		27	14	9:10	48
2		27	15	7:50	49
1		27	15	11:45	49
2		26	15	7:35	50

*p. m.

cornua remain attached to the inner membrane lining the puparium even after the fly has emerged.

A pupa that had transformed on April 4, was examined 10 days later by cutting away its pupal shell. It appeared as a white, grublike, rather soft, shapeless mass. Its head, legs and wings were only slightly developed, and the anterior respiratory cornua just mentioned were short and close together, and had not yet pushed through the outer shell. The cornua appeared reddish brown when they first became visible but soon turned darker.

Another pupa was examined on April 27 which was further advanced in its development. Its body appeared plump, white and grublike and its partly developed wings and legs were folded so that they fitted together along the depression between the head and abdomen. Its eyes appeared orange colored with darker brownish patches near the centre. The respiratory cornua projected through two round holes in the caplike anterior end of the puparium.

TABLE 2. INTERVAL AFTER PUPATION BEFORE FIRST EXTERNAL APPEARANCE OF ANTERIOR RESPIRATORY CORNUA ON PUPAE OF *Merodon equestris*

No. of pupae	Date of pupation	Date of first appearance of respiratory cornua	Time	Remarks
	1926	1926	Days	
1	Apr. 15	Apr. 24	9	at 12:30 p. m.
1	17	26	9	
2	15	25	10	
2	13	24	11	at 8:15 a. m.
7	8	22	14	

EMERGENCE. Observations indicate that the fly requires very little time for forcing its way out of the puparium. In spite of almost constant observation of perhaps a hundred pupae, the flies were usually ready to tumble out before their activity attracted attention. In fact this act was accomplished so speedily that in only two instances was it actually seen. In each case not more than a minute elapsed before the fly had succeeded in freeing itself from the puparium and making its escape. (See Table 3.)

The fly after emerging usually climbed some support, such as the bulb foliage or the wooden label in the pot, where it would be exposed to the air. Its wings appeared rather damp and crumpled at first, and did not become fully spread until from 10 to 39 minutes later. The interval from emergence until the spread wings relaxed and became folded along the back varied from 35 to 60 minutes. Some individuals were observed to use their wings for flight as early as 10:30 a. m., the same

day they emerged. Ordinarily flight was not attempted for several hours after emergence, even though the wings appeared normal after one hour.

The following records indicate that the flies normally emerge early in the morning and that about seven out of every eight flies emerge before noon:

80 flies emerged between 6:00 a. m., and 9:00 a. m.
25 emerged between 9:00 a. m. and 12:00 m., and
15 between 12:00 m. and 5:00 p. m.

Moreover it was found that a number of those emerging after noon were quite obviously delayed by low temperatures, and by rain which had fallen overnight and during the forenoon. These observations, together with records already presented in Table 1, show that a few individuals had actually emerged before 6:40 a. m.

TABLE 3. TIME REQUIRED FOR EMERGENCE OF *Merodon equestris* FLIES UNTIL THE WINGS ARE FOLDED

Sex of fly	Date of emergence 1926	Head of fly out of puparium at a. m.	Fly free from puparium a. m.	Time for emergence Minutes	Wings fully spread a. m.	Time for expanding wings Minutes	Wings folded at a. m.	Total time elapsed Minutes
Male	May 17	7:44	7:45	1	8:23	38	—	—
Female	17	8:51	8:52	1	9:10	18	9:52	60
Male	17	—	8:55	—	9:13	18	9:35	40
Female	18	—	7:25	—	7:50	25	8:15	50
Male	18	—	7:45	—	7:55	10	8:20	35
Female	17	—	8:05	—	8:44	39	—	—
Female	17	—	9:55	—	10:05	10	—	—
Male	19	—	7:43	—	8:05	22	—	—

FEEDING. The flies were kept confined in screened insect cages in the outdoor screened insectary already mentioned under "rearing methods," and were fed daily by smearing a few drops of extracted honey on the screen tops of their cages where they could lap it up. They fed freely on bright clear days, but remained inactive and did not eat when the weather was cold, dark, or rainy.

Drinking water was provided each morning by placing on the floor of the cage a shallow watch glass which contained a film of water not more than one-fourth inch deep, in order to keep the flies from getting too wet by falling in it.

The Narcissus fly because of its size is sometimes referred to as the greater bulb fly to distinguish it from the lesser bulb fly, *Eumerus strigatus* Fallen. It resembles a bumblebee to some extent not only in

its size and coloring but also in its actions. It is stout-bodied, and about half an inch long. Its body color is usually shining black, ornamented with short, yellowish and black hairs arranged in such a manner that it often appears to have a black band across either or both the thorax and abdomen. The color pattern is, however, extremely variable. One entirely black female fly with dark wings was reared last spring, and there are occasional yellow individuals.

The fly gives a very clever imitation of a bee by humming and buzzing or hovering over flowers. It was noted that they were strongly attracted to the blooms of roses, especially the variety "Silver Moon," but gave little attention to such nectar bearing flowers as honeysuckle, columbine, and mock orange blooms.

PROPORTION OF SEXES. The proportion of sexes as based on records for 120 flies that emerged during May 1926, indicates a ratio of about 122 females to every 100 males. The eyes of the male flies are set close together, but are distinctly separated in the females.

MATING. The duration of copulation as observed on May 14 and 15 varied from 3 to 11 minutes, and the air temperatures associated with this activity ranged from 64 to 84° F. (see Table 4). Mating took

TABLE 4. DURATION OF COPULATION OF *Mercdon equestris* FLIES

Date	Time of copulation		Duration of copulation	Air temperature
	Beginning	End		
1926	a. m.	a. m.	Minutes	°F.
May 14	8:20	8:27	7	66
14	8:20	8:26	6	66
15	8:35	8:40	5	75
15	8:15	8:21	6	74
15	8:40	8:48	8	75
15	9:00	9:11	11	76
15	9:04	9:10	6	76
15	10:15	10:21	6	78
15	10:22	10:27	5	79
15	10:26	10:32	6	79
15	10:30	10:37	7	81
15	10:26	10:33	7	80
15	10:40	10:46	6	82
15	11:05	11:11	6	82
17	8:10	8:20	10	64
	p. m.	p. m.		
14	12:31	12:34	3	78
14	1:02	1:07	5	78
15	12:00	12:05	5	82
15	1:30	1:35	5	84
15	1:45	1:48	3	84
15	2:45	2:50	5	84
15	3:00	3:04	4	84

place most frequently during the forenoon, and in bright sunlight. The earliest hour noted was 8:20 a. m. and the latest 3:04 p. m. Of the 73 observations made, 53 instances of mating were noted during the morning hours and only 20 in the afternoon.

OVIPOSITION. In order to get data on the number of eggs laid by individual flies, 3 were isolated in lantern globe cages immediately after mating, and kept under daily observation until death. They had emerged on May 15; mated on May 17; and two began egg laying on May 19 at the same hour. One fly died without depositing any eggs, and a total of 93 eggs were found inside her body. Two of these flies laid their eggs at irregular intervals, as indicated in Table 5. The totals of deposited and undeposited eggs for these individuals were 97 and 96 eggs respectively. This indicates a capacity of approximately a hundred eggs per fly. One fly that was dissected immediately after emergence contained more than ninety eggs as small round white discs.

TABLE 5. NUMBER OF EGGS FROM THREE *Merodon equestris* FLIES THAT EMERGED ON MAY 15, AND WERE ISOLATED IN LANTERN GLOBE CAGES IMMEDIATELY AFTER THEY HAD MATED ON MAY 17, 1926

Hour of mating A.M.	First oviposition Hour P.M.	Date 1926	Number of eggs laid per day during May 19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	Date of death 1926	Total no. eggs Laid	Not deposited	Total eggs per fly
9:20	——	——	0	0	0	0	0	0	0	0	–	–	–	–	–	–	–	–	–	5/27	0	93	93
9:30	2:40	5/19	27	0	0	0	0	0	0	53	0	0	3	0	0	0	0	–	–	6/3	83	14	97
10:10	2:40	5/19	22	2	15	10	0	5	1	6	0	0	0	13	0	0	0	0	–	6/4	74	22	96

No less than 1,248 eggs were deposited by the 66 female flies that were under observation. Twenty-four of these flies were dissected after death, and were found to have retained about 535 undeposited eggs. A number of flies that had lived for from 18 to 28 days deposited all their eggs even under cage conditions, and it seems reasonable to assume that flies having unrestricted choice of the bulbs in a field might deposit nearly all their eggs.

It appeared to make little difference whether one or one hundred eggs were deposited on a bulb, for in most instances only one larva developed successfully in it. As many as seven very young larvae were found in one bulb during the summer, but only two bulbs out of more than a hundred that were examined on November 10 contained two larvae.

It seems probable that in some instances eggs were infertile, for it was noted that the eggs deposited by one individual failed to hatch and when broken gave no evidence of embryonic development.

Oviposition took place only during the day, the earliest record being 8:45 a. m., and occurred most frequently in the afternoon between two

and four o'clock. The following records indicate that after noon is the favorite time for egg laying:

May 19.— 60 eggs were laid between 7:30 a. m. and 11:15 a. m.
45 between 11:15 a. m. and 2:00 p. m.; and
100 after 2:00 p. m.
May 21.— 18 eggs were laid in the forenoon and
100 in the afternoon.

Eggs were rarely laid on cold, cloudy or rainy days. For example, no eggs were deposited on May 16 which was a rainy Sunday with an air temperature of about 57° F. June 6, likewise, was a dark cloudy day with a temperature of 62° F., and no eggs were laid.

When ready to lay, the female fly was observed to seek a suitable place for her eggs by crawling about with her ovipositor extended and curved downward in contact with the soil or bulbs. After finding a crevice in the soil or a space between the sheath and stem, or between the layers of skin enclosing the neck of such bulbs as amaryllis, narcissus or onion, the fly inserts her ovipositor and places one or more eggs so that they are usually hidden from sight. She remains near the bulbs for from 2 to 5 minutes before flying away. (See Table 6.) Just after deposition the eggs can easily be found by examining the exposed crown of the bulb, but a few days later rain or water may have washed them out of sight so that it may be practically impossible to locate them again.

Eggs were laid singly or groups of two or three but sometimes more were grouped together. For example, as many as 11 eggs were counted in a single cluster; 7 was a frequent number; and 8 occurred once. An isolated female laid 5 eggs in a single cluster, and as many as 53 on one bulb the same day.

TABLE 6.—TIME SPENT BY *Merodon equestris* FLIES IN OVIPOSITING

Date	Time of oviposition		Time spent near bulb
	Began	Flew away	
1926	p. m.	p. m.	Minutes
May 15	12:00	12:05	5
15	1:50	1:54	4
15	3:05	3:07	2
15	3:07	3:11	4
15	3:25	3:30	5
21	2:55	2:58	3
17	11:20*	11:22	3
17	11:20*	11:25	5

*a. m.

PREOVIPOSITION PERIOD. The interval of time from the date of emergence to the first egg laying, as based on records for seven flies, varied from 2 to 6 days. (See Table 7.) It was also found that egg deposition began from 2 to 4 days after mating had taken place.

TABLE 7. PREOVIPOSITION RECORDS FOR SEVEN *Merodon equestris* FLIES

Fly No.	Date of emergence 1926	Date of mating 1926	Date of first oviposition 1926	Duration of preoviposition period Days
1	May 9	May 11	May 15	6
2	10	11	15	5
3	15	17	19	4
4	15	17	19	4
5	15	17	19	4
6	17	18	20	3
7	18	19	20	2

POSTOVIPOSITION PERIOD. Records for five individuals shown in Table 8 indicate that a postoviposition period of from 2 to 4 days may intervene between the date of final egg laying and the death of the fly.

TABLE 8. POSTOVIPOSITION RECORDS FOR FIVE *Merodon equestris* FLIES THAT EMERGED ON MAY 15, 1926

Fly No.	Date of last oviposition 1926	Date of death 1926	Duration of postoviposition period Days
1	May 29	June 2	4
2	29	1	3
3	30	3	4
4	31	2	2
5	June 10	14	4

LONGEVITY. The length of life of 52 male flies was found to vary from 1 to 25 days with an average of nearly 17 days. (See Table 9). Records for 54 female flies gave an average of about 16 days, and a range in longevity of from 3 to 28 days. (See Table 10). It was noted that 42 per cent of the flies lived 20 days or longer.

Under cage condition the flies injured their wings, or in some instances broke them off entirely, by flying against the screen with their wings in full vibration. This injury sometimes prevented flight, and caused some eggs to be laid on the floor of the cages, but did not appear to be serious for the flies could still crawl, and were able to continue their usual activities of feeding, mating and ovipositing. In general, the flies appear rather sturdy and are not easily killed.

TABLE 9. LONGEVITY RECORDS FOR 52 MALE *Merodon equestris* FLIES

No. of flies	Date of Emergence 1926	Date of Death 1926	Length of life Days
1	May 18	May 19	1
4	15	19	4
3	17	25	8
1	18	27	9
1	18	28	10
1	15	26	11
1	17	29	12
1	18	30	12
1	17	30	13
1	18	31	13
1	22	June 4	13
2	9	May 23	14
1	9	25	16
2	10	27	17
2	11	28	17
1	11	29	18
1	17	June 4	18
2	12	May 31	19
1	12	June 1	20
4	15	4	20
1	18	7	20
1	19	8	20
2	13	3	21
3	12	3	22
3	13	4	22
2	13	5	23
1	15	7	23
5	14	7	24
1	15	9	25
1	16	10	25

INCUBATION PERIOD. In 1926, during May and early in June, eggs hatched in from 10 to 14 days. (See Table 11). The average time required appeared to be about 12 days. The air temperatures during this period varied for the most part between 60° and 80° F., and it is believed that these rather low temperatures may have increased the time needed for incubation this spring.

When ready to emerge the larva chews or tears an irregular hole in the egg shell near one end and crawls out.

SIZE OF LARVA. The following figures indicate the maximum size of larvae found at varying ages:

Newly hatched	1.5 mm. long by 1.5 mm. wide
5 days old	2.5 mm. long by 0.75 mm. wide

1 month old	6.0 mm. long by 2.0 mm. wide
2 months old	13.0 mm. long by 4.0 mm. wide
3 months old	15.0 mm. long by 5.0 mm. wide
5 months old	15.0 mm. long by 5.0 mm. wide
160 days old	17.0 mm. long by 6.0 mm. wide

TABLE 10. LONGEVITY RECORDS FOR 54 FEMALE *Merodon equestris* FLIES

No. of flies	Date of Emergence 1926	Date of Death 1926	Length of life Days
1	May 17	May 20	3
1	17	21	4
1	18	22	4
1	15	20	5
1	18	24	6
1	9	16	7
1	10	17	7
1	10	18	8
1	17	25	8
1	18	26	8
2	10	19	9
1	18	27	9
4	15	25	10
1	18	28	10
1	10	21	11
1	15	27	12
1	18	30	12
1	10	23	13
1	11	24	13
1	18	31	13
1	11	25	14
1	15	29	14
1	18	June 1	14
1	11	May 26	15
1	18	June 3	16
2	17	3	17
1	15	2	18
1	17	4	18
1	18	5	18
1	15	4	20
1	19	8	20
2	12	4	23
1	17	9	23
6	14	7	24
1	16	9	24
3	13	7	25
3	14	8	25
1	15	9	25
1	17	14	28

TABLE 11. DURATION OF INCUBATION PERIOD OF *Merodon equestris* EGGS DURING MAY AND JUNE, 1926

No. of eggs	Date of Deposition 1926	Date of Hatching 1926	Duration of incubation period Days	Remarks
2	May 30	June 9	10	
2	June 1	11	10	
3	May 15	May 26	11	
5	17	28	11	
3	18	29	11	
5	19	30	11	
1	22	June 2	11	
6	23	3	11	
2	24	4	11	At 1:00 p. m.
4	25	5	11	
1	27	7	11	
5	29	9	11	
6	15	May 27	12	Several hatched by 7:30 a. m.
12	18	30	12	
4	19	31	12	
100	18	30	12	
51	21	June 2	12	
32	22	3	12	
5	23	4	12	
3	24	5	12	
2	25	6	12	
1	30	11	12	
1	15	May 28	13	Hatched by 9:15 a. m.
51	18	31	13	
3	19	June 1	13	
31	20	2	13	
5	21	3	13	
1	22	4	13	
1	24	6	13	
2	21	4	14	

It is evident from the above measurements of larvae that the greatest increase in size takes place during the first two months.

NATURE AND EXTENT OF INJURY IN BULBS

From the evidence thus far obtained it appears that the newly hatched larvae begin feeding in the basal plate of the bulbs, and later bore through the centre of the bulb, causing it to assume a badly discolored and soft or rotted appearance.

Eggs laid May 18 were placed on a bulb and allowed to hatch there and infest it without being disturbed. This bulb was cut open on June 3, after the larvae had entered it, and five distinct holes were found bored

through the basal plate. One of the larvae was feeding near the top of the bulb. After they had been feeding for eight days the centre of the bulb was blackened.

A larva that hatched on May 28 was placed on a bulb and allowed to feed in it for a week. On examination it was found that the larva had burrowed down through one of the outer bulb scales from the neck to the basal plate, leaving a brownish and discolored channel to mark its trail, and had then turned and started to eat its way back through the centre of the bulb.

Another small bulb was completely destroyed after five weeks feeding by a larva that had hatched on May 28. This larva had then abandoned the bulb and crawled outside into the soil. On July 7 the basal plate of a large King Alfred narcissus bulb was discolored after five weeks feeding, but the centre had not yet been touched. A six weeks old larva that had been feeding in one bulb for 19 days had practically destroyed the centre of it. On July 26, another larva that had been feeding in a bulb for three weeks had damaged it considerably, and had then gone down into the basal plate.

Degree of Infestation. To illustrate the severity of infestation by the three bulb pests of the bulb material which was available for the fumigation experiments, the following observations based on the results of examination of 498 bulbs are presented:

A total of 383 *Merodon* larvae were present in 349 infested bulbs; 313 of these bulbs contained only one larva in each bulb; 32 had two; and 2 had three.

One hundred ninety-five bulbs were infested with *Eumerus* larvae and contained 1066 specimens. The maximum number counted in a single bulb was 42.

A total of more than 34,204 mites, including mature, immature, and hypopal stages, were counted in 376 infested bulbs.

Control Experiments

Carbon Disulphide Fumigation of Infested Bulbs. Late in November 1925, a supply of King Alfred narcissus bulbs that had recently been imported from Holland was forwarded to this Bureau for experimental use. As already stated, these bulbs were heavily infested by larvae of both species of bulb flies, and all stages of the bulb mite.

These infested bulbs afforded an excellent opportunity to get data on the practicability of fumigation with carbon disulphide without the use of vacuum or other special equipment for vaporizing the chemical more rapidly. The object was to place in the hands of the grower a simple and

effective method of treating bulbs under field conditions for the control of these bulb pests, especially in cases where nematode (*Tylenchus d·psaci*) infestation did not occur and make necessary resort to the hot water treatment. With this purpose in mind a series of preliminary experiments were planned. The results of these tests proved to be so decisive not only in regard to insect and mite mortality, but also in their effects on the subsequent growth and flowering of the bulbs, that it was decided they should be published in order to make the information available as a basis for future investigation of this problem. Owing to the fact that these results are based on long exposures and are only preliminary in scope they cannot be used as a basis for making actual control recommendations until more extensive work has been done. They do, howver, serve to suggest the possible range of effectiveness of this fumigant. Especially, provided the chemical can be vaporized fast enough to permit short exposures that would insure insect mortality without injuring the bulbs. The summarized results of these experiments are presented in the form of three tables.

A series of eight of these fumigation tests were conducted during the month of December 1925. Since these experiments are presented in the same order in each of the three tables, and include bulbs that were fumigated at the same time under identical conditions, a statement of the conditions of treatment will apply in each case.

Experiment No. 1 represents an untreated "check;" No. 2 was fumigated at the rate of 10 pounds of carbon disulphide per 1,000 cubic feet of space, under a 27-inch vacuum, and with an exposure lasting 2 hours; Experiments No. 3 to 8 were fumigated under normal atmospheric pressure; No. 3 was fumigated at the rate of 10 pounds, and with an exposure lasting 2 hours; Nos. 4 and 5 were fumigated at rates of 10 and 15 pounds respectively, and with exposures of 23½ hours; Nos. 6 and 7 were fumigated at the rate of 20 pounds, and with exposures lasting 12 and 23½ hours respectively; No. 8 was fumigated at the rate of 30 pounds and the exposure lasted 23½ hours.

The dosages used were based on the work with vacuum fumigation done by the California State Department of Agriculture, which placed a limit of from 25 to 30 pounds of carbon disulphide per 1,000 cubic feet, under a 27-inch mercurial vacuum and with a 1¾ to 2 hour exposure, as the dosage rate for bulb fumigation. The length of exposure was increased to 23½ hours when it was found in Experiment No. 3 that under normal atmospheric pressure at least one-fourth of the amount of carbon disulphide liquid used failed to vaporize within two hours, even at a dosage rate as low as 10 pounds per 1,000 cubic feet of space.

The dosage rates in subsequent experiments were also increased because the 10 pound rate with an exposure lasting 2 hours had proved ineffective, even under a 27-inch vacuum.

The data on insect control presented in Table 12 are the composite results of examination of from two to four different lots of infested bulbs at varying intervals of time after the fumigation. The first examination in most instances was made in December 1925, approximately ten days after treatment. Other examinations were made early in January, and the final examination was made about the middle of March in 1926.

TABLE 12. RESULTS OF FUMIGATION WITH CARBON DISULPHIDE UNDER NORMAL ATMOSPHERIC PRESSURE OF KING ALFRED NARCISSUS BULBS INFESTED WITH LARVAE OF *Merodon equestris*, LARVAE OF *Eumerus strigatus*, AND BULB MITES, *Rhizoglyphus hyacinthi*

Exp. No.	Date of fumigation 1925	Dosage CS_2 per 1000 cu. ft. Pounds	Length of exposure Hours	Total No. of bulbs examined	Effects of fumigation on *M. equestris* larvae No.	Per cent Control	*E. strigatus* larvae No.	Per cent Control	*R. hyacinthi* mites No.	Per cent Control	Remarks
1	Dec. 2	0	0	62	40	0	113	0	6044	0	Check, untreated
2	2	10	2	62	41	2.4	93	0	5096	0	27" vacuum
3	2	10	2	62	37	0	116	0	8971	0	
4	16	10	23½	30	28	100	89	100	2220	90.0	
5	16	15	23½	30	25	100	107	100	933	96.0	
6	16	20	12	30	28	100	68	100	1856	97.8	
7	3	20	23½	110	90	100	300	100	5160	96.0	
8	3	30	23½	112	94	100	180	100	3924	99.4	

It is evident from the negative results of the first three experiments presented in Table 12 that dosages of 10 pounds of carbon disulphide and exposures lasting only two hours were ineffective in killing the bulb fly larvae and the mites either under a 27-inch vacuum or under normal atmospheric pressure. In fact there was no significant difference between the results of these tests and the untreated check. Although one dead *Merodon* larva was found in Experiment No. 2, there was some doubt whether this particular individual had died as a result of the fumigation. Experiments No. 4 to 8 inclusive gave 100 per cent mortality of the bulb flies, and a very high mortality of the bulb mite. In fact the earlier examinations of bulbs fumigated at the rate of 30 pounds and with an exposure of 23½ hours did give 100 per cent mortality of mature, immature, and hypopal stages of the mites. A few individuals, however, were present in the samples of bulbs that were examined during March, and these reduced the final percentages slightly, so that the mortality varied from 90 to 99.4 per cent.

In order to get a final check on the ultimate recovery or death of the bulb pests infesting this material, a sample of 20 bulbs from each of the 8 experiments was set aside and the flats in which they were planted were left undisturbed in the cold frame over winter. In the spring a screen frame was built over the flats to prevent the escape of any flies

that might emerge from the bulbs. Records were kept of such emergences, and the bulbs were eventually cut up and examined to determine whether they still contained any dead larvae, pupae, or mites. These results are presented in Table 13, and provide a very satisfactory check on the earlier results. No flies emerged except in the first three experiments in which living larvae and mites had previously been found. Only dead larvae, and very few mites could be found in Experiments 4 to 8 inclusive.

TABLE 13. FINAL EFFECTS ON *Merodon equestris*, *Eumerus strigatus*, AND *Rhizoglyphus hyacinthi* IN KING ALFRED NARCISSUS BULBS THAT WERE FUMIGATED WITH CARBON DISULPHIDE UNDER NORMAL ATMOSPHERIC PRESSURE IN DECEMBER 1925, AND GROWN OUTDOORS UNTIL MAY 1926

						M. equestris			*E. strigatus*			*R. hyacinthi* No. of mites		
Exp. No.	Date of fumigation	Dosage CS_2 per 1000 cu. ft.	Time of exposure	No. of bulbs examined	Date of examination	No. flies emerged	No. pupae not emerged	No. larvae dead	No. flies emerged	No. pupae not emerged	No. larvae dead	Dead	Alive	Remarks
	1925	Pounds	Hours		1926									
1	12/2	0	0	20	5/20	12	6	0	20	4	0	0	2143	Check, untreated
2	12/2	10	2	20	5/20	6	3	0	3	1	0	0	1366	27 inch vacuum
3	12/2	10	2	20	5/20	14	1	0	14	4	0	0	1759	
4	12/16	10	23½	20	5/1	0	0	12	0	0	6*	0	89	
5	12/16	15	23½	20	5/1	0	0	14	0	0	9*	0	14	
6	12/16	20	12	20	5/1	0	0	15	0	0	18*	0	35	
7	12/3	20	23½	20	5/1	0	0	12	0	0	0*	0	32	
8	12/3	30	23½	20	5/1	0	0	13	0	0	3*	0	22	

*Larvae badly decomposed; some unrecognizable.

The results presented in Table 14 show the effects of fumigation on the vegetative and flowering qualities of the bulbs and are based on the same samples of bulbs as those mentioned in Table 13. The data on flowering were taken on April 19, 1926, at which time the bulbs were already blooming. The results for the first three experiments, as indicated by the number of blooms, do not show any significant difference that cannot be explained by the fact that the hearts of some of the bulbs were no doubt destroyed by larval feeding and were thus prevented from blooming. The lack of blooms in Experiments 4 to 8 is attributed to the injurious effects resulting from the long exposure to the carbon disulphide fumigation. In Experiments No. 7 and 8, where dosages of 20 to 30 pounds were used, the treatment was absolutely fatal, and in fact the injury showed up soon after treatment as a brownish discoloration of the basal plate of the bulbs. By reducing the exposure to 12 hours, a few bulbs managed to survive a dosage of 20 pounds, and even produced a couple of blooms.

TABLE 14. FINAL EFFECTS ON THE VEGETATIVE AND FLOWERING QUALITIES OF KING ALFRED NARCISSUS BULBS THAT WERE FUMIGATED WITH CARBON DISULPHIDE UNDER NORMAL ATMOSPHERIC PRESSURE IN DECEMBER 1925, AND GROWN OUTDOORS UNTIL MAY 1926

Exp. No.	Date of fumigation 1925	Dosage CS, per 1000 cu. ft.	Time of exposure	No. of bulbs examined	Date of examination 1926	Effects of fumigation on bulbs: No. of rotted bulbs	No. of bulbs with: Roots	Foliage	Flowers*	Remarks
1	12/2	0	0	20	5/20	1	19	19	8	Check, untreated
2	12/2	10	2	20	5/20	1	18	18	7	27 inches vacuum
3	12/2	10	2	20	5/20	1	19	16	7	
4	12/16	10	23½	20	5/1	5	7	11	2	
5	12/16	15	23½	20	5/1	19	1	1	0	
6	12/16	20	12	20	5/1	15	5	5	2	
7	12/3	20	23½	20	5/1	20	0	0	0	
8	12/3	30	23½	20	5/1	20	0	0	0	

*Records on Flowering were taken on April 19, 1926.

PRESIDENT ARTHUR GIBSON: Mr. C. A. Weigel will now read his paper.

HOT-WATER BULB STERILIZERS

By C. A. WEIGEL, *Entomologist, U. S. Bureau of Entomology, Washington, D. C.*

ABSTRACT

A brief discussion of the various types of sterilizers used to disinfect narcissus bulbs imported under special permit and in accordance with the Federal Horticultural Board requirements.

According to the present restriction, which became effective January 1, 1926, governing the entry of narcissus bulbs from foreign countries, all such imported bulbs shall be given the hot water treatment either at the port of arrival or other designated point, provided suitable equipment is available at such a place. Such treatment "involves the submersion of bulbs in wire baskets, slat boxes, or other containers, in water ranging in temperature from 110° to 111.5°. F., for a period of not less than two and one-half hours." The object of this restriction is to prevent the further entry into this country of the three important bulb pests, viz., the narcissus fly, *Merodon equestris* Fab; the lesser bulb fly, *Eumerus strigatus* Fallen; and the bulb nematode, *Tylenchus dipsaci* Kuhn; against which the hot water treatment is supposed to be effective.

Subsequent to the issuance of these requirements numerous requests were received by the Department of Agriculture for information regarding the construction and operation of such sterilizers. A preliminary survey of the subject soon revealed that comparatively little was known in this country concerning equipment for treating bulbs in hot water.

In view of this fact it seemed desirable to undertake a study of the

underlying principles involved in the construction of apparatus for this purpose, particularly the methods employed in maintaining a constant and uniform temperature of the water throughout the period of treatment. One source of such information was the literature available on the subject. Another, was the sterilizers, limited in number, which had already been constructed in this country prior to the placing of the restriction. A third source was the data which each permittee was required to furnish and file with the Board when application was made for a special permit to import narcissi, the information being needed in order to determine whether the importation could be adequately handled. These data consisted of a detailed description of the proposed apparatus illustrated with plans and photographs, and through the courtesy of Dr. C. L. Marlatt and Mr. E. R. Sasscer, of the Federal Horticultural Board, they were placed at the writer's disposal. The writer is indebted for assistance rendered by Mrs. A. E. Harrell in the office of the Board, in assembling these data from the various files pertaining to this subject.

According to the literature available it is apparent that the most important developments in foreign countries are due to the researches of Ramsbottom, of England, and Van Slogteren, of Holland.

Ramsbottom, (*1, p. 481–483*), whose investigations were begun in 1916, ultimately found that by soaking narcissus bulbs in water at a temperature of 110° F. for three hours the bulb eelworm, *Tylenchus dipsaci*, could be destroyed without injury to the growth of the plant. The period of three hours should be recorded from the moment the bulbs are placed in the bath because, in deciding upon the three hours' treatment, allowance was made for the fall of several degrees in temperature that always takes place when the bulbs are immersed. This drop in temperature, however, is generally regained in from 15 to 30 minutes.

Van Slogteren, (*2, p. 14*), simultaneously, but working independently, arrived at virtually the same conclusions.

This treatment is also claimed to kill the larvae and pupae of both species of bulb flies, *Merodon equestris*, and *Eumerus strigatus* Fallen.

In this country C. E. Scott (*3, p. 502*), of the California Department of Agriculture, has conducted some experiments for the control of the bulb nematode, and concludes that the "treatment of bulbs in hot-water at 110° Fahrenheit for three hours is the most promising method." Similarly, C. F. Doucette (*4, p. 250*) points out that "The information in the table substantiates the statements that the standard three-hour treatment at 110° Fahrenheit is fatal to the fly larvae and mites."

As a result of Ramsbottom's and Van Slogteren's work, commercial

concerns became interested and three types of apparatus were devised, two of which are somewhat similar in principle and construction. The earlier of these consisted of an outer kettle, which in some cases was insulated, and an inner tank of metal with perforated sides or wire baskets suspended for holding the bulbs in the water bath. The water within the inner tank is heated by means of a gas or oil flame applied directly to the rounded bottom. The constancy of temperature of the water is controlled by a hand-operated valve, or by a thermostat which, operating a specially devised valve, regulates the flow of gas or oil.

In England one of the thermostatically controlled types, known as the Hearson Bulb Bath, is now available in three sizes, the smaller one having a holding capacity of about 200 medium-sized bulbs, and is designed for use by the hybridist and grower of small stocks of expensive varieties. The next size will hold 84 pounds, while the largest bath can treat 150 pounds at one time. For convenience of handling and changing the bulbs, especially in the larger outfits, it is desirable to soak them in open, coarse sacks, each sack holding about 42 pounds of bulbs.

In Holland an apparatus known as the "Armadill" sterilizer, was developed by Dr. Van Slogteren (*5*), is available, and involves virtually the same principles as the ones just described. It is circular, or kettle shaped, is about 42 inches in diameter by 36 inches deep, and has a capacity of about 150 liters. It has an outer metal wall, insulated with cement, and is provided with a specially designed thermometer which can be read at a distance of several feet. To assist the thermal circulation three iron pipes, open at the ends, are strapped together in a row and placed in an upright position in the middle of the tank, the lower ends resting on a slat floor placed several inches from the bottom. These pipes also serve to keep the bags of bulbs from jamming each other and forming a solid mass, which might interfere with the circulation of the water among the bulbs.

In these first types that were developed in Holland and England no special provision appears to have been made for agitating or circulating the water, the heat being distributed chiefly by thermal circulation. This is a vital factor in the efficiency of such equipment. According to D. B. Mackie (*6, p. 26*), of the California Department of Agriculture, the time required to heat a bulb varies with its initial temperature and with the extent of agitation of the water. For example, still water at 110° F. requires about sixty minutes to bring to 110° the temperature of the centre of a 2-inch bulb whose initial temperature is 69°. The same bulb, submerged in violently agitated water, takes up heat sufficient to raise its temperature to 110 degrees in 20 minutes, thus shortening

the period by 40 minutes. The effect noted is consistent with the experimental results of heat transmission.

The second type of apparatus, known as the Barford and Perkins Sterilizer, consists of a boiler for supplying steam to heat the water in the one or more circular tanks, and a steam coil provided with a specially patented arrangement of valves for controlling the temperature. It is constructed in two standard sizes, with a soaking capacity of 5 cwt. and 8 cwt., respectively, for each circular tank.

The steam boiler, which when set up is about 10 feet away from the tank, is of the low-presssure type, being 2 feet in diameter by 4 feet 6 inches high, and is provided with a pressure gauge and safety valve and 12-foot chimney. An automatic feed maintains the water in the boiler at a constant level and is so arranged that it can be coupled to the cold-water supply. A pressure head of not less than 8 to 10 feet of water is required to supply the automatic feed tank. The boiler is set to blow off at a gauge pressure of 2 pounds. The firebox of the boiler will burn coal, coke, wood or peat, and can also be constructed for burning oil or gas. Electric energy can also be used as a source of heat.

The circular tank for the 500-pound capacity is 3 feet 6 inches in diameter by 3 feet 6 inhes high; that for the 900-pound outfit is 4 feet 6 inches in diameter and 4 feet high. The tank is fitted with a set of special valves which control the amount of steam admitted to the coil, which in turn maintains the temperature of the water. The coil is located on the bottom of the tank, below the slat floor upon which the bulbs rest during treatment. The slat floor is about 10 inches above the bottom and prevents the bulbs from coming in contact with the steam coils. A draw-off permits quick emptying of the water and cleaning out. The capacity of the equipment can be increased by adding a second tank, for the heating of which the boiler is fitted with a three-way cock. There is but one size of steam boiler, which is supplied with each outfit, the difference being in the size of the tanks. The coal consumption is given as less than 80 pounds per day of 10 working hours. Three soakings can be made in a ten-hour day, giving a total of $1^1/_8$ tons with the 8-cwt. plant.

The thermometer for this plant is of special pattern. It is about 4 feet long, and is enclosed in a brass tube fitted with a disc, which allows the thermometer to rest on the central pipe, immersed to the correct depth. This central pipe is perforated, and enables the temperature to be read in the centre of the mass of bulbs; but this brass-cased thermometer can be immersed at any other part of the tank without fear of breakage. The column of mercury is flattened, so as to be as wide and as easily read as possible, and the scale is a very open one, i. e., only a few degrees are marked on either side of the working temperature. It is, therefore, possible to have a large and very obvious rise of the mercury column for each degree Fahrenheit, so that the thermometer can be eas ly read from a distance of 12 to 15 feet. A red mark is drawn across the scale at 112°, showing the point above which the temperature of the water cannot be allowed to rise without risk of injuring the bulbs.

When sterilizing, the supply of steam is regulated to maintain the water in the sterilizing tank at the correct temperature, by opening or closing one, two, or three of the valves. Valve number 3, which is nearest to the tank, has the smallest opening, while number 1 has the largest. It is claimed that the temperature can be adjusted to vary not more than one-half of a degree Fahrenheit. As in the previously mentioned

type, the circulation is entirely thermal, and in order to allow space for the water to circulate freely the bulbs are placed in coarse mesh bags filled not more than half full.

In the United States according to the records of the Federal Horticultural Board, about a dozen of these machines have been installed since the restriction has become effective, and all appear to be giving satisfaction. The largest of these, located near Los Angeles, Calif., consists of three 900-pound tanks, and a boiler, which is heated by conveniently available natural gas.

In operation, according to the reports from the various inspectors of the Federal Horticultural Board who have supervised the treating of imported bulbs in the past season, there appears to be a drop of 6 to 8 degrees in temperature when the bulbs are immersed, and from 15 to 20 minutes are usually required to regain this loss before the whole mass becomes equalized in temperature. This was accomplished by opening all four valves until the temperature rises to 111° F., after which number 1, and if necessary number 2, were closed, to maintain a constant temperature.

The third type, also a Barford and Perkins sterilizer, is essentially the same in principle and in construction, with the exception that provision is made to circulate the water in two distinct circuits. This type was really the forerunner of the one just described. Because of its large size, however, its usefulness was limited to concerns growing very large quantities of bulbs. To meet the demand for a smaller outfit, which could be used by growers of less acreage, the second type was evolved.

Since the first equipment was made in Holland, it has been improved so that the heating can be done by means of either hot water coils or gas burners. The apparatus is known as the "Bloembollen Ketel met Telegas regulateur" and is manufactured by the Gebr. Schouten, Lisse, Holland. One of the newer designs, which was installed and tested at North, Va., early in August, 1926, performed very satisfactorily during the 3 hours of testing. This apparatus consists of a hot-water boiler and two sheet-iron tanks, each 7′ 6″ long, by 4′ 6″ wide and 2′ 6″deep. These dimensions, however, may be varied according to the capacity desired. There is a slat floor, raised approximately 10 inches from the bottom, allowing a depth of 20 inches for actual treating space. Lying on the bottom are the hot-water coils which heat the water. Each tank is divided into five sections by four upright 3-inch pipes, fastened together in a row, but open at each end. The pipes, open at both ends, serve two purposes; they facilitate thermal circulation and keep the bags of bulbs separated, thereby preventing them from forming too solid a mass during the treatment. In each of the sections it is possible to

place four bags of 1½ bushels each, allowing a total of 20 bags, or 30 bushels of bulbs. With both tanks in operation it is possible to treat 60 bushels in one charge.

The temperature is controlled by a specially designed, water-actuated thermostat. The apparatus is provided with a large thermometer in each tank, somewhat like that used in the English sterilizers. In determining the temperature of the bulbs during the treating period, it was found that there was a difference of ¼ to ½ degree in temperature between the water in the tank and that in the inside of the gunnysacks filled with bulbs.

This apparatus can also be equipped for direct heating by gas rings placed underneath the tanks, the thermostat in such cases controlling the flow of gas, thus holding the temperature within the desired range.

According to Mr. M. Kisliuk, who supervised the treating of imported bulbs in one of the "gas-heated" machines near Reading, Pa., the thermostatic control functioned satisfactorily. A fairly constant and uniform temperature of 110.5° F. was maintained throughout the bulb mass during the period of treatment. For the safety of the bulbs, the thermostat is set so that the temperature cannot exceed 112° F. Similarly, Mr. F. W. Hecker, an inspector of the Federal Horticultural Board, who supervised the treatment of imported bulbs in this type of gas-heated apparatus at Benton Harbor, Mich., reports that "After removing one batch of bulbs and inserting another, it would cause the temperature to drop 5 to 7° F., but it very seldom took more than 15 to 25 minutes to bring the temperature up to 110.5° F. again."

California Bulb Sterilizer

In the United States the pioneer investigation of this subject was made by D. B. Mackie and his associates, of the California Department of Agriculture. As early as 1921 a dipping vat was developed and used in connection with treatment of certain kinds of nursery stock. This apparatus differs from others in that it is electrically heated and thermostatically controlled. With the rapid expansion of the bulb industry in California the demand for effective treatment of infested bulbs became urgent and resulted in the improvement of the dipping vat, so that a very efficient type is now available.

This latest equipment now known as the California Floral Bulb Sterilizer, consists of a tank made of heavy sheet metal 9′ long, 2′ wide, and 2′ deep to a horizontal wire screen. The frame is reinforced with angle iron, and the tank is insulated with asbestos. The asbestos insulation is protected on the outside by tongue-and-groove sheathing.

The bottom below the screen is either rounded or V-shaped, with a depth of 15 inches below the false bottom or screen, on which rests the baskets.

Each vat is provided with seven baskets, five being in the vat at one time; two auxiliary baskets can be filled or unloaded while the others are in the process of treatment. The contents by volume of each basket is 5½ cubic feet, but, to enable freer movement of the bulbs, a load is limited to 4 cubic feet. The baskets are placed in the vat and removed from it by means of a tackle and merchandise conveyor; they are placed in the vat in rotation at 30-minute intervals, the first basket being removed at the end of 2½ hours and replaced by a fresh one. The next is removed 30 minutes later, and so on. This rotation provides for the least possible disturbance of the water temperature and for a better distribution of labor.

Heating is accomplished by two 220-volt immersion heaters of the bayonet type, each having a rated capacity of 4 kilowatts. A thermostat operates a relay, which in turn actuates the switch controlling the immersion heaters. To insure a uniform temperature and to assist in the rapid transfer of heat from the water to the bulbs, the water is kept in agitation throughout the treatment. In the first sterilizers developed this was accomplished by means of an 8½-inch propeller set in the end of a 12-inch sheet-metal pipe, which lies longitudinally in the bottom of the tank. In the recently improved types it appears to be done by means of a centrifugal pump, which discharges water directly among the bulbs through a series of jets under the screen bottom, one jet being placed under each basket. In either case, power for agitation is derived by means of a motor connected either directly or by a belt to a propeller or a pump.

This type of sterilizer requires that provision be made for having preheated water on hand; when it is to be used, the vat is first filled with hot water of approximately the desired temperature, and then operated with the electric immersion heater, thermostatically controlled. In sections of the country where cheaper electric current is available as on the Pacific Coast, for example, this type of vat can be heated by electricity alone, unless, of course, the time required for heating the water to the desired temperature of 110° F. is an important factor.

Steam-Heated Sterilizers

Since bulbs are now being grown extensively in certain districts of the Pacific Northwest, the growers soon realized the need of treating their bulbs in order to be able to maintain clean stock. Profiting by the ex-

perience of others, they developed a new and unique style of bulb sterilizer. In it steam is used for heating the water in a separate heater, and the temperature is kept constant and uniformly distributed by means of both agitation and circulation. The makers and first users of this apparatus appear to be W. C. Franklin, of Portland, Oregon, and F. A. Chervenka, of Sumner, Washington, both being extensive growers.

Mr. Franklin describes this sterilizer in the Florists' Review, Volume LVII, No. 1475, issued March 4, 1926, pages 34 to 36, as follows:

> An iron tank was employed, but wood will do as well, about nine feet long, three and one-half feet wide, and three and one-half feet deep. At one end of the tank an 8-inch marine propeller was placed close to the bottom, operated by an electric motor and set to run at 875 revolutions per minute, for the purpose of circulating the water. About twelve inches from the bottom, a false floor made of boards running horizontally with the tank was inserted. There is a space of six inches on both sides of this false bottom to allow the water to come up along the sides of the tank.
>
> On the other end of the tank there is an outlet pipe, connected with a rotary pump. From this outlet pipe the water is pumped through a water heater, which consists of a water jacket inside of which is a copper coil. Enough steam is sent through this copper coil to keep the water at the required temperature. The steam is controlled with two ⅜-inch and two ¼-inch needle valves. One valve of each size will control the flow of steam just as well as two.
>
> In heating the water at first, a live steam pipe is carried from the boiler into the tank, and the steam is used to raise the water to the desired temperature, 111° Fahrenheit, after which the heater is used to keep the water at that temperature. When the water is taken through the outlet and pumped through the heater, it is carried back to the tank and released behind the propeller, and it is again sent circulating among the bulbs. The water is maintained at a uniform temperature at all times.
>
> No difficulty has been found in holding that even temperature. In the treatment of our bulbs the temperature of the water has never gone below 110 degrees nor above 111½ degrees. To keep watch on this, a certified thermometer has been used, and the circulation has been so good that we have not found any variation of temperature in any part of the tank.
>
> As containers for the bulbs, we used baskets made from ½-inch mesh wire screen, made on frames twenty-four inches deep, thirty inches long and twelve inches wide, outside measurements. These were constructed so that the top part of the frame extends over the edge of the tank far enough to allow the baskets to hang on the edge. There is space between the baskets, and between the baskets and the walls of the tank, to insure a good circulation of the water. The capacity of the tank is about one-half ton of bulbs.

The writer has had opportunity to test several machines of this type, and has found that they performed very satisfactorily when operated on high-pressure steam. If the steam pressure dropped too low, however, difficulty was experienced in maintaining a constant and uni-

formly distributed temperature. Aside from the cost, this apparatus may be considered very desirable and efficient, because the water can be heated quickly to the desired temperature, and the temperature can then be maintained satisfactorily. In addition, it has two distinct systems for keeping the water in motion, i. e., by circulation and by agitation. Its disadvantages are that the temperature-control valves are operated by hand and the temperatures must necessarily be checked by accurate thermometers at frequent intervals.

This type of sterilizer has been further improved by assembling and attaching the pump, motor, water heater, and control valves to one end of the tank, thereby obviating installation of these parts on the floor and walls of the building in which it is set up. This equipment is known as the "Rogers" type, a patent for which is now pending.

United States Department of Agriculture Bulb Sterilizer

During the spring of 1926, R. L. Swenson, Mechanical Superintendent of the Department of Agriculture, and the writer devised plans for the construction of a sterilizer incorporating most of the ideas which have thus far been brought out. In this apparatus the heating is done by steam coils which are placed in the bottom of the tank, and the temperature is controlled by means of an air-actuated regulator, or thermostat. This thermostat is of the automatic bimetallic immersion type, and admits or discharges air by the expansion and contraction of the metallic element, actuated by the minute changes in the temperature of the water in the sterilizer. The air is admitted to or released from a diaphragm valve, which in turn admits or throttles the steam supply. The water is agitated by two marine propellers, one placed in each end of the tank and driven by an electric motor, their action making two circuits of water in the vat. The tank is of virtually the same dimensions as those devised by Mr. Mackie and growers in the Northwest. The details of construction can be varied according to the availability of the materials, wood or metal, in a given locality. It is equipped with two electric immersion heaters, so that if one source of heat gets out of order the other can be used. The water is brought to the critical temperature by injecting live steam through special hot-water heaters, after which the heat is maintained by either the automatically controlled steam coils or the electric immersion heaters. A recording thermometer can be used to keep for reference the temperatures during each charge. To facilitate handling the bulbs, transferring them into the vat and out of it, a chain hoist and overhead traveling carriage is provided.

Since this apparatus incorporates many of the desirable features of the various machines thus far developed, its construction necessarily costs more, but its efficiency is accordingly increased.

The types thus far described are of sufficient capacity to suit the needs of the average grower; and by adding one or more units the requirements of a larger establishment can be met. But there are several commercial concerns of such size that they require equipment of a much greater capacity than those discussed above.

One of these mammoth plants has been installed near Charleston, South Carolina, and has a treating capacity of almost 100,000 bulbs in one 3-hour charge. The unique feature of this plant is that the heated water is passed down through the bulb mass.

The equipment consists of a huge boiler, designed for wood burning, and a sterilizing tank about 36 feet in length. The tank is divided into 5 compartments, each capable of holding 5 specially designed wire baskets. A continuously traveling crane is installed over the sterilizing vat, the loading, the cooling, and the unloading platforms. To this traveling crane is attached a loading frame designed to hold five sterilizing baskets, which constitute the contents of one compartment.

There are two vapor-operated recording thermometers, graduated in degrees Fahrenheit, and each is equipped with a device to safeguard the instrument from excessive temperatures. One temperature recorder is attached to the inlet, and the other to the outlet, of the water-circulating system of the sterilizer. The inlet recorder has a high-temperature alarm, which rings if the temperature exceeds 111° F.

The equipment also includes an arrangement for sterilizing the fouled, or used, water after every third or fourth batch of bulbs. This is accomplished through "by-passing" the steam directly into the heater, eliminating the temperature control from the circuit. The fouled water is then brought to 150° F., and can be held there for any desired period. Such treatment is considered sufficient to kill all stages of the bulb nematode. When the whole system is emptied the steam piping is so arranged that it is also possible to sterilize with live steam all parts of the sterilizer, including the dripping pit at the end of the vat, located underneath the dripping platform.

As the steam is generated it is fed to an instantaneous water heater capable of raising the temperature of 3,500 gallons of water from 70° F. to 110° F. in one hour, at a steam pressure of 15 pounds. Steam is fed to the heater by a supply pipe through a Sylphon regulator, set at 110° F. This supply pipe is used to add the initial heat to the water before the immersion of bulbs. After the water is heated to about

110° F. the bulbs are immersed and brought to the critical temperature, then this supply pipe is closed and a much smaller one is opened, to furnish the steam for replacing the heat lost from the entire system by radiation. This smaller steam supply pipe is equipped with a Sylphon steam regulator having a range of 100° to 140° F. but set for 110° F. when in operation.

The path of the water through the system is as follows: The water is discharged from a centrifugal pump driven by a gas engine, having a capacity of 200 gallons per minute, against a 40-foot head. The water then passes through the heater, its velocity being slowed down as it flows over the steam coil, and continues on to the sterilizing vat, where it is discharged into a distributing header. From this header five nozzles discharge into the upper part of each of the 5 compartments of the vat. Each unit of 5 nozzles is provided with a valve, to throttle the flow according to the requirements. The water now passes down through the bulbs by gravity and is drawn into a common header at the bottom of the tank, each of the compartments having two openings. From the common discharge the water is drained into a settling tank, provided with a baffle, intended to direct the flow of water so that all heavy materials will be collected at the bottom. The suction side of the centrifugal pump is connected to the top of the settling tank, thus completing the circuit of the water.

A second huge plant is located on Long Island, N. Y., and has a treating capacity of 60,000 bulbs per charge. In addition to the boiler and two large water heaters, this equipment includes a battery of six metal tanks, each with a treating capacity of about 80 cubic feet. To prevent loss of heat by radiation the metal tanks are insulated with a wall of hollow tile. Four specially made wire baskets, each of approximately 12.5 cubic feet capacity, and provided with covers, are made to fit each tank, so that when completely loaded the apparatus holds a total of 24 baskets. The temperature of the water is controlled by a thermostat actuating a solenoid-operated valve, which apparently performs very successfully.

The movement of water in this outfit is accomplished by means of a unique system of circulation. The preheated water is injected into the bottom of each tank so that it enters the baskets of bulbs from underneath and rises up through the mass of bulbs. An overflow outlet near the top allows the water to return by gravity into a huge collecting sump or vat, where it is screened and filtered and then pumped back through the steam coil heaters, where it is again brought up to the critical temperature, and sent through the mass of bulbs as before.

The water is preheated in the following manner: When starting the treatment, the sump is filled with water, the pump started, and the water circulated through the two heaters and back to the sump. In this operation the temperature-control features are eliminated through "by-passing" the water as soon as it leaves the heaters. When the water in the entire system reaches about 111° F. one of the heaters is cut off and the solenoid valve is put into service on the line from the boiler to the other heater. The solenoid valve is connected to a special thermostat which can be set at the critical temperature. If the water passing the thermostat ever exceeds 111.5° F. a bell alarm is sounded, so that the operator can by-pass the overheated water directly to the sump, thereby safeguarding the bulbs from injury caused by excessive temperatures.

The bulbs are then immersed, the "by-pass" from the heater to the sump closed, and the water allowed to circulate for the required period through the sterilization tanks containing the bulbs. By staggering the time of loading each tank, this apparatus permits a continuous operation without unduly upsetting the temperatures, as might result if it were loaded to capacity at one time.

A third large treating plant which has been installed near Sanford, Florida, includes six large tanks about 10′ x 3′ x 2′ 6″ in size, and twenty-four specially built baskets for immersing the bulbs. Its total treating capacity for one charge is about 50,000 bulbs. In many respects this apparatus is very similar to the one just described; but the water is heated in a separate tank by electric heaters thermostatically operated. After the bulbs are removed from the water bath they are cooled by placing the baskets or containers on a conveyor which carries them underneath an apparatus for spraying cold water.

Another mammoth plant has been installed near Scottsville, Texas, and has a treating capacity of approximately 100 bushels per charge. It consists of three separate metal vats, each being about 15′ long by 2′ wide and 2′ deep. Each vat is provided with 8 wire baskets, each of 5 cubic feet capacity. These baskets are lowered into or raised out of the vats with an overhead traveling crane. Agitation of the water is produced by a marine propeller, of suitable size, placed in the bottom of each vat. A steam injector is used in each vat for heating the water before the bulbs are immersed. This sterilizer is almost identical in general style and principles with the one developed by the Department of Agriculture, except that it is built in three separate units. This feature has decided advantages, especially for continuous loading and unloading, as it not only hastens the treating process but also prevents an

excessive fall in temperature which might easily result if the sterilizer were loaded to full capacity at one time.

From the reports received from the Federal Horticultural Board Inspectors who have supervised the treating of bulbs in these mammoth sterilizers, it is evident that each plant functioned satisfactorily.

In conclusion, it may be stated that while most of the types of sterilizers discussed in this article functioned more or less satisfactorily, it appears that the most efficient types are those which have the following features incorporated in their construction:

1. Provision for keeping the water in motion, either by propulsion or circulation.

2. The temperature-control device, whether manual or automatic, should be capable of maintaining the temperature accurately within closely prescribed limits.

3.. The source of heat energy, whether electricity, or steam or hot water boilers, heated by gas, oil, coal, or wood, must be of sufficient capacity to bring the entire volume of water up to the critical temperature as rapidly as possible. If of sufficient capacity to do this, it will, obviously, also be capable of maintaining a constant temperature.

4. Efficient insulation is needed, to prevent too rapid a loss of heat by radiation.

5. The treating capacity should be adequate to handle within a reasonably short period of time the stock of bulbs to be treated.

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MR. E. P. FELT: May I inquire whether it is necessary to provide for the drying of these bulbs at all, or is just draining sufficient.

MR. C. A. WEIGEL: If the bulbs are to be shipped directly after treating, they must be dried. The drying process has not been gone into very thoroughly yet and is going to be a problem in case of interstate

movement, where bulbs are found to be infested and will have to be treated for interstate movement, unless they can be dried slowly in the fields or under special drying sheds.

MR. E. N. CORY: I would like to ask Dr. Wiegel whether he anticipates that carbon disulphide fumigation will be an acceptable substitute for steam.

MR. C. A. WEIGEL: Carbon disulphide is not effective against a nematode. It is necessary there to use the hot water treatment. But considerable work must be done with the use of the carbon disulphide also. There have been setbacks in some of the work, and that must be gone into a little more closely.

MR. E. P. FELT: Can you rely on its killing the larvae?

MR. C. A. WEIGEL: If it is properly done.

MR. R. B. ARNOLD: I would like to ask the price of the smaller electric heater sterilizers.

MR. C. A. WEIGEL: I think the price is about $550 f.o.b. Los Angeles, but these English machines are very small units and can be bought all the way from $31 up to $150. Of course then you have the import duty on them.

MR. W. E. FLEMING: I would like to ask Dr. Weigel how long it takes those bulbs to heat through the center.

MR. C. A. WEIGEL: According to D. B. Mackie, the time required to heat a bulb varies with its initial temperature and with the extent of agitation of the water. For example, still water at 110 deg. F. requires about 60 minutes to bring to 110 deg. the temperature of the center of a two-inch bulb whose initial temperature is 69.

MR. R. B. ARNOLD: Are the bulb flies disseminated around generally throughout all the states? Is that the reason why sterilizers have been put in?

MR. C. A. WEIGEL: No. As a result of a careful survey and checkup, we found that the bulb fly is definitely established on the west coast in certain localities only. In the East we have only one or two records of its definite and continuous establishment. After it has been established in a given locality, the tracing of that information has shown that in many cases a fly has merely emerged from bulbs that have been grown the previous fall, grown in the greenhouse and then thrown out on the refuse pile. I think in the East we have only a few records of definite establishment.

PRESIDENT ARTHUR GIBSON: The next paper is by F. F. Smith.

THE BLACK VINE WEEVIL (*BRACHYRHINUS SULCATUS* FABR.) AS A PEST IN GREENHOUSES AND NURSERIES

By FLOYD F. SMITH,[1] *Pennsylvania Bureau of Plant Industry, Harrisburg, Pa.*

ABSTRACT

This paper is presented as a progress report on the studies of *Brachyrhinus sulcatus* Fabr. in the nurseries and greenhouses of Pennsylvania. Its distribution in Pennsylvania, the possibility of its being distributed by means of Taxus as balled nursery stock, and the relationship between greenhouse infestations and Taxus are discussed. Life history studies thus far indicate that greenhouse plants are infested by adults developing out of doors. The species is capable of parthenogenetic reproduction. Dry lead arsenate mixed with the potting soil gives promise of one method of control for this insect on greenhouse plants.

The black vine weevil (*Brachyrhinus sulcatus* Fabr.), also called black weevil and cyclamen weevil, has been frequently mentioned in American literature since 1890 as being injurious to various plants, especially in the greenhouses of the northern United States and of Canada. Cyclamens, primroses, and gloxinias in greenhouses, and strawberries and Taxus out of doors seem to be most frequently mentioned. In Europe, where the species is widespread, grapes are most severely attacked although peaches, raspberries, and greenhouse plants are also troubled. A list of about thirty host species has been recorded from both continents. Feytaud[2] who has made practically the only economic study of this species, found that it has one generation annually in the vineyards of France. American literature includes notes on injury and suggestions for control.

DISTRIBUTION. Some disagreement is noted among our American writers as to whether this is an imported or a native insect. In Pennsylvania during the past year this weevil has been found on Taxus on a large number of Philadelphia estates. In many of the nurseries throughout the eastern part of the state adults were taken on the same plant, and none were taken by intensive collecting on other vegetation in the immediate vicinities. All these infested Taxus were either imported or were purchased from a few large New Jersey or Pennsylvania nurseries which propagate this plant in large quantities. The latter group of nurseries was found to be infested to varying degrees. In New Jersey, losses of Taxus caused by this insect[3] have been severe in some years, while the Pennsylvania nurserymen, with one exception, have

[1]The writer appreciates the advice concerning methods of study and the criticism of this paper by Dr. T. L. Guyton and Dr. C. A. Weigel.

[2]Feytaud, J. Bull. Soc. Etude Vulg. Zool. Agric. Bordeaux., Vol. 16, No. 5, pp. 33–42. May, 1917.

[3]Weiss, H. Jour. Ec. Ent., Vol. 8, pp. 552. 1915.

experienced no trouble. In the fall of 1913 one local firm imported large quantities of Taxus with roots in soil from Holland. The following spring quite a number of these plants drooped and died, and larvae thought to be those of *B. sulcatus* were found girdling the roots.

In a few nurseries where Taxus has been grown only from seed and no plants in soil have been brought in, no weevils were found. These observations point toward the probability that local distribution, at least, of this insect has been largely by means of infested nursery stock.

In eastern Pennsylvania a few commercial florists and quite a number of gardeners on estates have experienced annual losses to greenhouse plants for as long as fifteen years. In nearly all cases Taxus, infested with this weevil, has been found growing quite near each of these greenhouses.

INJURY. The young grub feeds first on the small rootlets and then, later, either devours the larger roots entirely or cuts them off and burrows into the crown or corm of the greenhouse plants. On Taxus the fleshy bark of the larger roots is eaten. The latter type of feeding is rapid and takes place as the larva is completing its growth which is in November and December in greenhouses, or in April and May out of doors.

The effect on the plant of this rapid feeding manifests itself rather suddenly; the florist usually suspecting nothing until his plants suddenly wilt down as they are being brought into bloom for the holiday sales.

The adults feed on the foliage and flowers.

LIFE HISTORY. Larvae taken May 7, 1926, from about the roots of Taxus were just completing their feeding and were forming prepupal cells. Adults emerged from this material June 16–29. Oviposition began among a few of these individuals on July 20, but the others, together with about 150 collected adults, began egg laying about August 1st. The greater number of eggs were laid during August, but a few continued oviposition until September 18th.

The eggs as laid were transferred to primroses and cyclamens in the greenhouse, where larval development was completed in about 3½ to 4 months. The maturity of these larvae during November and early December corresponds with observations on the injury to the plants and on the conditions of the insect in a number of greenhouses during the past two seasons.

At the beginning of oviposition six isolated adults were placed under greenhouse conditions where an average of 342 and a maximum of 654 eggs were laid. Ten isolated adults kept out of doors laid an average of 138 and a maximum of 377 eggs.

In order to obtain evidence on the possibility of the species breeding continuously in greenhouses, studies were begun with larvae maturing on cyclamen in November and December, 1925. From this material adults emerged during the following January and February. (The period from egg to adult under greenhouse conditions would then be 5½ to 6 months.) These adults began oviposition in April on an average of 67 days after emergence, and continued to lay eggs until October, when the greenhouse temperature dropped because of a faulty heating system. The adults then became rather inactive and fed very little. The greatest number of eggs laid during this period by one adult was 1085. Maturity of larvae from the first laid eggs took place in late July and the others developed regularly at later periods. None of the florists troubled with this insect in this locality have observed larvae or injured plants at any time other than late fall.

Further studies of greenhouse practices show that conditions are generally unfavorable for continuous breeding of this pest within doors. The houses are pretty well cleaned out by spring sales or by destruction of unsalable plants. Plants for the next season's crop are then potted up from seed flats or very small pots. If these winter-emerging adults should oviposit during the spring among the small plants, the limited root systems would furnish insufficient material for complete larval development. This is evidenced by the fact that a few newly hatched larvae will destroy the roots of a primrose in a 2½-inch pot before reaching the third instar.

PARTHENOGENESIS. Larvae isolated during 1925 developed into adults which were kept in individual cages. Eggs from each of nine isolated virgins hatched into larvae and these developed into female adults, showing that at least one generation can develop without the intervention of the male. No males have been found among the hundreds of adults examined during the course of this study. This is in agreement with Feytaud's[4] work in which he found not a single male in a dissection of over 3,000 adults.

EGG. Eggs are found tucked into soil crevices, in loose trash or leaves on the ground, or among the leaves or stems of the plants.

The egg is almost spherical, about .65 mm. in diameter, and when first laid is a glistening, pearly white color. After 24 to 48 hours the color of the majority of the eggs changes to a light brown and in 15 to 21 days they hatch into larvae. About 8 per cent to 11 per cent of the eggs, however, do not change color but finally decompose without hatching.

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[4]J. Feytaud. Acad. Sciences, Paris. Vol. 165., No. 22, pp. 767–9. 1917.

This peculiarity is here mentioned since one would expect 100 per cent fertility of eggs in parthenogenetic reproduction.

LARVA. As soon as hatched, the larvae enter the ground in search of rootlets. If the surface is firmly packed the larvae seem unable to burrow into it and will die within a short time. Even firmly packed sand offers a great deal of resistance, and a smooth clay seems impenetrable. This point is suggested as the reason for the severe injury to Taxus in the New Jersey nurseries where the soil is light and porous, and the absence of the pest in injurious numbers on the same plant growing in the heavy Pennsylvania soil. The mortality of the young larvae is probably much greater in the latter situation.

After entering the soil, growth and feeding for a few weeks, or until about the end of the third instar, are slow and the larvae are usually located among the small rootlets. Feeding and growth then become rapid and the larger roots are attacked. A cell is constructed for each molt, and when mature a rather firm pupal cell is constructed. In most cases pupation takes place within two inches of the soil surface in the nurseries, although often deeper in potted plants. Since the insect is easily injured in the late prepupal or pupal condition, cultivation during late May in outdoor plantings may break up these cells.

PUPA AND ADULT. The pupal stage lasts about ten days, and after transformation the adult remains within the cell for a week or more or until the body is well hardened. The adults, whose elytrae are fused along the median line, cannot fly. They feed only at night, and are inactive during the day, hiding under trash or among the plant stems. On Taxus the greater number have been found in collections of needles among the branches, or beneath the loose bark. A dry place seems to be selected for a hiding place.

CONTROL. Control studies are now in progress. Of the soil treatments for larvae in greenhouse plants, the use of dry arsenate of lead mixed with the potting soil seems to offer some promise, as indicated by Table 1. The arsenate of lead may be readily added to the potting soil as the florist usually mixes known quantities of soil, leaf mold, manure, and sand, for each particular kind of plant.

In cage tests adults readily ate and were killed by a bait composed of dried apple waste which had been thoroughly coated with five per cent, by weight, of either magnesium arsenate or of dry lead arsenate. This same bait, together with a number of others, was applied to the soil surface about the bases of large Taxus plants but without success. The adults, whose habits in this situation were arboreal, were not lured to the ground.

Summary

1. The black vine weevil is apparently quite widely distributed in eastern Pennsylvania and seems to be associated with Taxus under out of door conditions. The distribution of this plant as balled nursery stock may be its disseminating agent.

2. Infested Taxus has been found growing in the vicinity of nearly all greenhouses in Pennsylvania where the hothouse plants have been injured by this weevil.

3. Life history studies indicate that the weevil does not ordinarily breed continuously in the greenhouses but that probably a few adults developing out of doors enter the greenhouse each season and deposit eggs.

4. According to the present knowledge, reproduction seems to be entirely by parthenogenesis.

5. Results of tests which have been made by mixing lead arsenate in the soil as a larvicide are given.

TABLE 1. RESULTS OF TESTS USING LEAD ARSENATE IN POTTING SOIL AS A LARVICIDE FOR *B. sulcatus*

	No. plants	Species of host plant	Lead arsenate per bushel of soil Ounces	Date introduced 1926	Number of larvae	Instar No.	Date Examined 1926	No. larvae found	Remarks	
A	1	Primula obconica	0.5	July	5	2	2-3	Aug. 24	0	
	1	Primula obconica	2.0		5	2	2-3	24	0	
	1	Primula obconica	4.0		5	2	2-3	24	0	
	1	Primula obconica	0.0		5	2	2-3	24	2	Check. Roots eaten.
B	1	Primula malacoides	16.0	Aug.	13	4	3-4	Sept. 23	0	
	1	Primula malacoides	16.0		13	2	3-4	23	0	
	1	Primula malacoides	0.0		13	3	3-4	23	2	Check.
	1	Primula malacoides	0.0		13	1	3-4	23	0	Check.
C	1	Primula malacoides	16.0	Sept.	4	6	3	Oct. 19	0	
	1	Primula malacoides	16.0		4	6	3	19	0	
	1	Primula malacoides	0.0		4	6	3	19	6	Check. Roots eaten.
	1	Primula malacoides	0.0		4	6	3	19	4	Check. Roots eaten.
D	2	Primula malacoides	16.0	Sept.	19	120	*	Nov. 3	0	*Eggs. (60 per plant).
	1	Primula malacoides	0.0		19	60	*	3	16	Check. Roots eaten.
	1	Primula malacoides	0.0		19	60	*	3	19	Check. Roots eaten.
E	2	Cyclamen	0.5	Nov.	14	6	2-3	Dec. 6	0	
	2	Cyclamen	2.0		14	9	2-3	6	0	
	3	Cyclamen	4.0		14	13	2-3	6	0	
	1	Cyclamen	8.0		14	3	2-3	6	0	
	1	Cyclamen	0.0		14	3	2-3	6	3	Check. Roots eaten.
	1	Cyclamen	0.0		14	3	2-3	6	3	Check. Roots eaten.
	1	Cyclamen	0.0		14	2	2-3	6	2	Check. Roots eaten.

No detrimental effect of lead arsenate at any rate of above mixtures in the soil has been noted on the plants. When introduced in the 3–4th instar very few larvae were killed in tests at any rate of mixture of lead arsenate in the soil up to 8 ounces per bushel. Earthworms seemed to flourish as well in the soil containing 16 ounces of lead arsenate per bushel as in the checks.

PRESIDENT ARTHUR GIBSON: We will now listen to a paper by M. A. Stewart.

A MEANS OF CONTROL OF THE EUROPEAN HEN FLEA (*CERATOPHYLLUS GALLINAE* SCHRANK)[1]

By M. A. STEWART, *University of Rochester, Rochester, New York*

ABSTRACT

This paper very briefly describes the control of the European hen flea (*Ceratophyllus gallinae* Schrank), a potential pest of considerable economic importance to poultrymen, by spraying the buildings with Phinotas Disinfectant and dipping the birds in the same material.

The following briefly described method of control of the European hen flea (*Ceratophyllus gallinae* Schrank) was discovered during the summer of 1923, while conducting research work for the Crop Protection Institute under an appropriation from the Phinotas Chemical Company of New York City, on the control of the external parasites of domestic animals, by means of Phinotas Disinfectant. An infestation of fleas in a commercial poultry plant in Eliot, Maine was brought to the attention of the writer by Prof. P. R. Lowry of the University of New Hampshire and investigation showed these pests to be *Ceratophyllus gallinae;* eggs, larvae, pupae, and adults being found in great numbers. The means of introduction of this parasite into the plant, which is the first record of its occurrence in the state of Maine, is unknown but the effect was so serious that the owner believed that he would be forced completely out of business within a short time, due to the appalling decrease in egg production and the great loss of weight in the birds, causing them to become unmarketable. European workers have recognized the existence of this species in the United States only within the last few months, after specimens were sent abroad by the writer to prove their presence here.

This flea breeds in the nests and on the floors of poultry houses (and also perhaps in the nests of some of the wild gallinaceous birds), remaining on the host only to feed and possibly during copulation. Its life history and habits have not been at all completely worked out but it is a very active insect, breeds very rapidly, and is very hardy, being able to withstand extremely unfavorable environmental conditions. The writer has observed adults still alive after direct exposure to the weather in open trap nests filled with litter, for a period of two months. The litter in these nests had been completely soaked frequently during this time. Both larvae and adults were found here. *C. gallinae* not only attacks poultry but also any other animal, including man, which enters the infested building or comes in contact with the infested litter. However, they will not continue to live on the accidental host.

[1]This paper is presented with the permission of the Board of Governors of the Crop Protection Institute.

The insecticide used in this work was Phinotas Disinfectant manufactured by the Phinotas Chemical Company of New York City. The birds were housed in the commonly used modern type of colony house, consisting of several pens, separated by solid partitions and connected by doors cut through, under one roof. The method of control found to be effective, after determining the minimum lethal dose and the strength least irritating to the skin of the birds, was as follows: the pens were thoroughly cleaned, all of the litter being burned. The path of transportation and the ground around the burning place for a radius of fifteen feet was thoroughly sprayed with one part disinfectant to ten parts water, mixed at tap water temperature, to kill any fleas which may have escaped from the litter during transportation and burning. The droppings were buried and the ground around the burying pit was likewise sprayed for the same reason. After this was completed the first pen in the colony house was emptied of birds by placing them with those in the second pen and the walls, ceiling, roosts, dropping boards, and floor were very thoroughly sprayed with a mixture of 1 part disinfectant and 10 parts water, at tap water temperature as before, under 250 pounds pressure by a gasoline motor spraying machine, such as is used in spraying orchards. Then all of the birds in pen number 2 were dipped in a mixture of 1 part disinfectant to 60 parts water, heated to about 82 degrees Fahrenheit to lessen the physical shock. The birds were dipped at the door connecting pens 1 and 2 and were put into the previously disinfected pen, no time being allowed for the drying of either the birds or the pen. All of the pens in each colony house were treated in the same manner, progressing from one end of the building to the other by first disinfecting the pen and then dipping the birds and putting them into it.

The birds were dipped by grasping each one firmly under the wings with the right hand, immersing it in the dip, and thoroughly ruffling the feathers with the left hand, thus allowing the disinfectant to reach all of the feathers and all parts of the body. The head was immersed as well as the rest of the body, with no ill effects to the eyes. Twenty-five hundred birds were dipped in this manner and not one of them appeared to suffer any permanent ill effects. Some of the birds were groggy for a few minutes following the treatment but were soon moving about again as usual. Dipping must be done in the morning and on a warm fair day in order to eliminate all unnecessary risk of the hens catching cold or suffering other ill effects from the drenching and exposure.

There was a considerable decrease in egg production for about a week following the treatment. The exact decrease could not be determined

because the owner had failed to keep accurate egg production records after the infestation became sufficiently serious to jeopardize his business. At the end of about a week's time the egg production began to increase very rapidly and in ten days more was back to normal. This return to normal might have taken place sooner had the vitality of the birds not been so greatly lowered by the prolonged attacks of the insects before treatment. An inspection of the birds two weeks after treatment showed them to be free of lice and mites as well as fleas, which was not true at the time of treatment.

One colony house was reserved untreated as a check. For the following month the infestation in this house constantly increased, thirty-eight birds out of six hundred and twenty-five dying, due apparently to the attacks of the fleas. At the end of this time the check house and its occupants were treated. Frequent reports were received from the owner of the plant for a period of three years, during which time there was not a single occurrence of the European hen flea.

From 58 to 60 quarts of solution (1 part disinfectant to 60 parts water) were used for every 125 birds; 15 gallons of undiluted disinfectant mixed with 150 gallons of water were used to spray every five pens, each pen being 20 ft. x 20 ft. x 12 ft. at the ridge pole.

This paper is presented to entomologists not only to report a new control for an economic insect but also because during the past year and a half while doing extensive work on the taxonomy and distribution of fleas, the writer has every now and then come across specimens of *C. gallinae* from different parts of the country, specimens having been taken as far east as Maine and as far west as Oregon. This fact coupled with the experience of having once observed a poultry plant suffering tremendous losses and threatened with complete failure due to this pest, moves him to bring to the atten of men engaged in the control of injurious insects the fact that here is sect which may at any time become a very serious menace to one of the largest phases of agriculture, since it has apparently gained a permanent foothold in the country as evidenced by its range of distribution.

QUESTION: What is the name of the manufacturer?

MR. M. A. STEWART: The Phinotas Chemical Company. I don't know their exact address; I didn't have it in my paper, but Professor O'Kane, or probably any other member of the Board of Governors at the Crop Protection Institute, under whose jurisdiction this work is carried on, can give you the exact address.

PRESIDENT ARTHUR GIBSON: Mr. C. R. Cleveland will present his paper.

STOMACH POISONS FOR CONTROL OF THE SQUASH VINE BORER (*MELITTIA SATYRINIFORMIS* HBN.)[1]

By C. R. CLEVELAND, *Purdue University Agricultural Experiment Station, West Lafayette, Indiana*

ABSTRACT

The squash vine borer (*Melittia satyriniformis* Hbn.) has until recently been considered uncontrollable by the use of insecticides, especially stomach poisons.

Three years experiments at Lafayette, Indiana, indicate that under certain conditions of exact timing and direction of applications, certain stomach poison insecticides give satisfactory and practical control of this insect at low cost.

On the basis of closely compared results from exact observations under identical conditions, Bordeaux 4–4–50-arsenate of lead spray gave the best control, viz., 88 per cent. Adhesiveness is an important factor in effectiveness.

Delayed planting, while effective in preventing infestation, is not practicable, since it results in a crop of uncertain quality or no crop at all.

The squash vine borer (*Melittia satyriniformis* Hbn.) is a troublesome and destructive enemy of squash in central Indiana, and doubtless in other parts of the state as well. Although not an important commercial crop in Indiana, a considerable amount of squash is grown in home gardens and by farmers as a small cash crop.

Repeated attempts in 1922 and 1923 in the entomological experimental garden at Lafayette to grow a small patch of Hubbard squash were complete failures, due to complete destruction of the plants by this borer. This resulted in spite of attempts to control the insect by the time-honored method of slitting the stems and removing the borers and mounding moist soil over the vines. It happened too often that hot dry conditions prevailed at the time of this operation and the vines never recovered from the borers or the operation or both. Late planting fails too often to produce a properly matured crop. Clean up of crop refuse in 1922 failed to save the crop of 1923, the moths probably coming from other nearby breeding grounds.

The problem attracted the writer, partly from a desire to find a control which would enhance his own chances of growing a crop of squash, partly as a means of providing a basis for more satisfactory recommendations to others, and partly from a desire to test the general possibility of spray control for insects of this nature which had not heretofore been considered controllable by the application of stomach poisons.

[1]Acknowledgment should be made to Mr. G. M. Stirrett for assistance in executing experiments and securing data during a portion of the progress of the investigations.

The squash vine borer hatches from an egg placed usually on the stem of the plant near its base. After hatching the tiny larva must eat its way from the outside through the surface and into the center of the stem. There is then at least a short period in which it must feed on the surface, and probably ingest particles of surface tissue. The period of oviposition and hatching is limited. Likewise the part of the plant attacked is largely restricted to a comparatively limited area. This combination of circumstances seemed to offer a possibility of control by careful, timely and properly directed applications of a stomach poison.

Experiments in Massachusetts (Worthley: Bulletin 218, Massachusetts Agricultural Experiment Station, 1923) apparently resulted in only about 50 per cent control with arsenate of lead spray, while nicotine sulphate, acting probably as an ovicide, secured as high as 100 per cent control. This degree of control, however, was secured only by use of high concentrations (1–100), resulting in a rather excessive cost. Furthermore only one arsenical was tested in the Massachusetts experiments, and nothing is said about the degree of care and effort practiced in securing an even coating of poison on all parts of the plant habitually attacked by the young borers.

It was therefore deemed advisable to inaugurate tests with stomach poisons keeping these various facts and conditions in mind.

Such tests have been conducted at Lafayette, Indiana, for the past three summers, 1924, 1925 and 1926. They have been carried out on a relatively small scale, so far as number of plants and ground are concerned, but the marked and consistent tendency of the results seems to fully justify positive conclusions.

1924 Experiments

Experiments of this year were of a small scale preliminary nature, and results were checked in a less exact and complete manner than in succeeding seasons.

Six plots of winter squash (Hubbard), each consisting of one row of six hills were planted. Each hill was thinned to four plants, so that each plot ultimately consisted of twenty-four plants. The first four plots were planted early, at about the earliest date possible for this section under ordinary practice. Two plots were planted later, as a test of the practical value of late planting for borer control. In addition, one plot of summer crookneck squash was planted early as a trap crop, and as an additional check on the effectiveness of the insecticide treatments employed.

Table 1 records data concerning planting, and treatments for all plots.

No advance schedule of treatments was outlined. Applications were

made, beginning within a period after germination when it was felt the plants would be covered in time to protect against the earliest hatched larvae, and continued as weather and growth conditions made it appear necessary. There were frequent rains during the earlier stages of growth, necessitating a relatively large number of applications. The effort was to keep the plants coated with poison at all times until all reasonable danger of oviposition and hatching was past.

Spray was applied with a hand bucket pump, using a medium fine disk angle nozzle, and special care was used to thoroughly cover all portions of the plants, especially the lower parts of the main stem. The dust treatments were applied with a hand duster of the bellows type in the same manner as the spray.

TABLE 1. PLANTING, GERMINATION AND TREATMENTS, 1924 EXPERIMENTS

Plot No.	Planted	Above Ground	Treatments
1 Winter (Hubbard)	June 6	June 16	None—Check
2 Winter (Hubbard)	June 6	June 16	Material . . . . . Arsenate of lead spray (1½ lbs. to 50 gals.) No. of applications . 1 2 3 4 5 6 Dates . . . . . June 27 June 30 July 5 July 11 July 20 Aug. 2
3 Winter (Hubbard)	June 6	June 16	Material . . . . . Arsenate of lead spray (1½ lbs. to 50 gals.) No. of applications . 1 2 3 4 5 6 Dates . . . . . June 27 June 30 July 5 July 11 July 20 Aug. 2
4 Winter (Hubbard)	June 6	June 16	Material . . . . . Calcium arsenate and gypsum dust (1-20) No. of applications . 1 2 3 4 5 6 Dates . . . . . June 27 June 30 July 5 July 11 July 20 Aug. 2
5 Summer (Crook-neck)	June 6	June 17	None—Check and Trap Crop.
6 Winter (Hubbard)	June 20	June 24	None—Late Planting.
7 Winter (Hubbard)	July 11	July 22	None—Late Planting.

TABLE 2. BORER INFESTATION AND INJURY—1924 EXPERIMENTS.

Plat No.	Total No. plants	No. infested	No. uninfested	Per cent plant infestation	No. plants killed	No. plants badly injured	No. plants with some injury	No. plants with no injury
1	24	24	0	100	22	2		0
2	24	2	22	8.3	1		1	22
3	24	0	24	0	0	0	0	24
4	24	0	24	0	0	0	0	24
5	15	15	0	100	0	2	13	0
6	24	0	24	0	All plants badly injured by *D. vittata*, resulting in 100% destruction by Aug. 19. Not reliable for borer records.			
7	24	0	24	0	—	—	—	—

The results in terms of borer control exceeded expectations. Observations were made from time to time as the season advanced, and the progress of infestation, growth and condition of plants recorded. No detailed observations of initial egg infestation, nor of numbers of borers which developed were made during this season. Degree of control secured is represented only by results in terms of number of plants finally showing infestation, and degree of injury shown by the plants in each plot.

Table 2 shows the results as they appeared on the date of final observation, Sept. 8.

Plot 7, planted July 11, apparently entirely escaped borer infestation but very dry weather immediately following germination, prevented growth, and all plants in this plot remained sickly and stunted throughout the season, producing no crop.

Plot 1 produced no crop.

Plots 2, 3 and 4 produced a good crop of marketable squash. Plot 5 produced only three squash of marketable quality.

1925 Experiments

The favorable indications of the 1924 results encouraged further experiments in 1925. Treatments tested in 1924 were repeated, and several other materials were added. Nineteen rows of four hills each, with two to four plants to the hills, in a piece of ground approximately 40 by 150 feet, were used, all of the winter Hubbard variety.

The entire field was first planted on June 13, and the first twelve rows came up June 24; but rows 13–19 failed to germinate, and were replanted June 29, coming up on July 7.

Unfortunately, pressure of other duties prevented close personal supervision of treatments and taking of data in this seasons experiments, and as a result less conclusive evidence was secured. No check plot was provided in the first planting, and since all of the later planting, rows 13–19, entirely escaped infestation, no check consisting of untreated plants was available for comparison with treated plots, where the planting was subject to infestation. Furthermore, through a misinterpretation of instructions, no exact count of borers was made, and no record of the exact number of plants infested and uninfested was kept. However, counts were made of the number of eggs deposited, as well as the resultant hill infestation. This, together with observation of the general condition of plants in all plots, and a rough estimate of the approximate percentage of borer infested and uninfested plants, does give some check on the efficiency of the treatments, and at least indicates a considerable degree of control resulting from their application.

All evidence secured by observations at Lafayette during three seasons work shows a low normal egg mortality for this species. In 1925 six plants, for example, bearing a total of 33 eggs, which were covered with screen wire cages July 2, with a mesh small enough to exclude moths and prevent further oviposition, but large enough to permit the ready entrance of egg parasites, failed to show any mortality, every one hatching, and the resulting borers pentrating the plant and developing to maturity.

Thus, by reference to the number of eggs deposited, and a general observation later as to approximate plant infestation and exact hill infestation, we secure strongly indicative evidence of the effectiveness of the controls tested.

Table 3 summarizes the results in terms of percentage of hill infestation by borers, from observations in August.

TABLE 3. RESULTS OF 1925 EXPERIMENTS

Plot No.	Row Nos.	Treatment	No. of hills	Hills infested	Hills not infested	Percentage hill infestation
1	1–2–3	Calcium arsenate and gypsum dust (1–20)	12	5	7	41+
2	4–5–6	Arsenate of lead (spray) (1½ lbs. powder to 50 gals water)	12	4	8	33⅓
3	7–8–9	Sodium fluosilicate and hydrated lime dust (1–9)	12	3	9	25
4	10–11–12	Arsenate of lead and hydrated lime dust (1–9)	12	3	9	25
5	13	None—check	4	0	4	0
6	14–15	Arsenate of lead and hydrated lime dust (1–9)	8	0	8	0
7	16–17	Sodium fluosilicate and hydrated lime dust (1–9)	8	0	8	0
8	18	Calcium arsenate and gypsum dust (1–20)	4	0	4	0
9	19	None—check	4	0	4	0

Plots 5–9 were the delayed planting, appearing above ground July 7. They showed no infestation either of eggs or borers, indicating that egg-laying had been completed before that date.

While the only exact records of borer infestation were those of hill infestation, the fact that detailed examination from June 24 to July 7 in plots 1–4 showed the presence of eggs on every plant, with an average of three per plant, and that later examination showed many plants and even entire hills in these plots free of borers, indicates a considerable degree of control resulting from the treatment. Plant infestation figures, if available, would doubtless show a considerably lower percentage of infestation than hill infestation figures.

Crop production records showed a fair crop of good quality well matured squashes from Plots 1–4. They show a production of relatively greater numbers and weight from Plots 5–9, but the squashes from these latter plots were mostly immature, and less marketable. One factor favoring heavier production from plots 5–9 was the fact that they were

grown on lower, deeper, richer soil which held its moisture better during dry weather.

It may be said that delayed planting again demonstrated its effectiveness as a borer control measure, but likewise its impracticableness from the standpoint of crop production.

1926 Experiments

Tests conducted during this season were the most exact in point of observation and record, and furnish the most representative and conclusive data of any of the three seasons during which this project was investigated.

Winter (Hubbard) squash was the variety used. They were planted in 8 rows of 10 hills each, with the hills in each row approximately 9 feet apart and the rows 9 feet apart. Rather close planting was necessitated because of lack of space. Each row constituted an experimental plot.

The plan and method of treatment were the same as in previous years. Materials used before were repeated, with one not before tested, Bordeaux and arsenate of lead spray, added. Dust applications were put on with a hand duster of the plunger type. Liquid sprays were applied with an air pressure sprayer equipped with a medium fine angle disk nozzle. Again the greatest care was exercised to thoroughly cover the stems with a coating of insecticide, and applications were made as deemed necessary from the standpoint of rains, plant growth, and the probable seasonal limits of oviposition activity by the moths.

Careful and exact records were made of the number of eggs deposited on the plants, number and amount of spray and dust applications, subsequent plant by plant borer infestation, degree of injury, and crop production.

The infestation proved to be lighter than in past seasons, possibly because of the enforced locating of the plots some distance away from previous plantings. The ground used, was, however, uniform in fertility and texture, providing a more reliable basis for crop returns.

Plots 1–7 were planted on June 9, and came up uniformly and strongly on June 17. Plot 8 was planted July 3 and came up July 12.

Four applications of the various treatments were made on the following dates: June 29, July 8, July 12, and July 14.

Table 4 summarizes the cost of materials per acre, of each treatment for the four applications and the results in terms of percentage of plants infested, number of eggs and borers and percentage of control.

All plants were examined for the presence of eggs on June 22, July 7, and July 10. Results show that maximum oviposition occurred within

TABLE 4. COST AND RESULTS OF 1926 EXPERIMENTS

Plot No.		Cost per acre for four applications	Egg infestation No. plants infested	No. plants not infested	Percentage infested	No. of eggs
1	Sodium fluosilicate and hydrated lime dust (1–2)	4.36	9	30	23+	19
2	Arsenate of lead spray (1½–50)	1.22	8	28	22+	14
3	Calcium arsenate and gypsum dust (1–20)	3.92	10	35	22+	21
4	Arsenate of lead and hydrated lime dust (1–9)	2.35	11	46	19+	20
5	Arsenate of lead and soap spray 1½–3–50	1.73	11	21	34+	24
6	Bordeaux 4–4–50 and arsenate of lead spray (1½–50)	2.77	15	43	25+	27
7	Check	—	16	35	31+	31
8	Late planting	—	0	60	0	0

Plot No.		Borer infestation No. plants infested	No. plants not infested	Percentage infested	No. of borers	Percentage control
1	Sodium fluosilicate and hydrated lime dust (1–2)	7	31	18+	10	47+
2	Arsenate of lead spray (1½–50)	8	27	22+	9	36+
3	Calcium arsenate and gypsum dust (1–20)	5	35	12+	6	71+
4	Arsenate of lead and hydrated lime dust (1–9)	6	45	11+	7	65
5	Arsenate of lead and soap spray 1½–3–50	8	20	28+	9	62+
6	Bordeaux 4–4–50 and arsenate of lead spray (1½–50)	3	45	6+	3	88+
7	Check	16	25	39+	31	0
8	Late planting	0	60	0	0	100

the two week period between June 22 and July 7, with some additional egg-laying from July 7 to 10. Further examination on July 13, failed to show any more eggs deposited, and in fact many of those previously observed could not now be found, indicating probable hatching. It should be remembered that 1926 at Lafayette was a relatively late season.

Examination for borer infestation and injury was made on Aug. 5, after all eggs had had an opportunity to hatch and the resulting borers to penetrate the stems. In determining the number of borers in each infested plant fine slits were very carefully made in the stems at points where frass exuded, and the larvae were located and counted, but were not removed. No plants appeared to suffer injury from this operation.

Percentage of control was calculated by comparing borer infestation with egg infestation, assuming practically a 100 per cent hatch in the absence of any treatment. This assumption appears to be reasonably justified because of records from the check plot, which shows 100 per cent hatch and development, and because of observations in the previous two years experiments which indicate a like tendency. There is of course some possibility here of experimental error, but the calculations seem to be closely and relatively reliable at least.

Variation in numbers of plants between the different plots is due partly to the fact that the striped cucumber beetle, which was very severe, killed some plants during the summer, and in fact completely destroyed two hills in plot 5 and one hill in plot 7.

From these results it is quite obvious that some measure of protection was secured with all the treatments applied. Arsenate of lead spray alone gave relatively poor results, sodium fluosilicate and lime very little better, calcium arsenate and gypsum, arsenate of lead and hydrated lime and arsenate of lead and soap only fair control. Bordeaux and arsenate of lead appears rather strikingly more effective, with 25 per cent of its plants originally showing egg infestation and only 6 per cent showing borer infestation and with only three borers out of 27 eggs surviving, giving the treatment a control percentage of 88+.

While an 88 per cent control of this insect is less than must be secured ordinarily under conditions of severe infestation in order to achieve highly satisfactory results in terms of freedom from injury, yet it does provide the margin existing between heavy loss and only moderate injury at least in the case of severe infestations, and indicates the possibilities of this kind of treatment. Further perfection of methods and materials undoubtedly could be accomplished which would yield still more satisfactory results.

Relative adhesiveness of the several sprays and dusts seems to parallel the results quite closely. The Bordeaux spray was most adhesive, traces remaining on the plants long after all signs of other treatments had disappeared. The other materials may be rated downward in respect to adhesiveness about as follows: (1) arsenate of lead and hydrated lime (2) calcium arsenate and gypsum (3) arsenate of lead and soap (4) sodium fluosilicate and lime and (5) arsenate of lead alone. It is not to be assumed from this that adhesiveness of a material is the only deciding factor in its effectiveness. Relative toxicity, repellancy to moths or young larvae or other properties may easily be involved.

Because of the comparatively light infestation in general, no very severe injury was produced, even on the check. However, degree of injury again follows in some measure the results in terms of borer in-

TABLE 5.—DEGREE OF INJURY—1926 EXPERIMENTS

Plot No.	Plants killed	Plants badly injured	Plants moderately injured	Plants slightly injured	Total number plants with some injury
1	0	0	0	7	7
2	0	1	2	5	8
3	0	0	0	5	5
4	0	0	1	5	6
5	0	0	1	7	8
6	0	0	0	3	3
7	1	4	6	5	16
8	0	0	0	0	0

festation and control. Table 5 summarizes this information. Some plants showing infestation had only one borer working at the base of a leaf stalk. In such cases there was no real injury, and they are not recorded.

As in previous years it will be noted that plot 8, late planted, escaped all infestation and injury, but it produced no marketable crop.

Conclusions

From a summary of three years experiments, it appears that the following general conclusions are justified:

1. That a satisfactory degree of control of the squash vine borer may be secured by spraying or dusting with certain stomach poison insecticides.

2. That the degree of control secured is dependent on a combination of several factors, viz. adhesiveness of the materials, timeliness of application, thoroughness of application and care exercised in directing the applications so as to thoroughly cover all parts of the plant most subject to attack during period of hatching.

3. The number of applications necessary to satisfy these requirements appears to be about four, beginning shortly after the plants appear above ground, and continuing for two to three weeks at intervals of about five or six days. These intervals are influenced by weather conditions, especially rain. Heavy rain should always be followed by a repeated application.

4. Of all insecticides tested under identical conditions in the same season, Bordeaux (4–4–50) plus arsenate of lead (1½–50) gave decidedly superior results. However, in 1924, under conditions of greater abundance of the insect, arsenate of lead alone and calcium arsenate and gypsum dust gave a high degree of control, up to 100 per cent. This difference in results between 1924 and 1926 may possibly be explained by greater frequency of early applications in 1924, thus providing better protection during the egg hatching period.

5. Per acre cost for materials, using stomach poison applications, is low, that for the most effective material of 1926, being only $2.77 for four applications. This cost is much below that for the only other insecticide treatment heretofore showing effective results, viz. nicotine sulphate.

6. Late planting, while effective in borer control, is not practical for central Indiana, resulting in poor maturity of the crop.

Adjournment: 12:15 p. m.

Thursday Afternoon Session, December 30, 1:30 p. m.

First Vice-President C. J. Drake presided.

FIRST VICE-PRESIDENT C. J. DRAKE: The first paper this afternoon is by D. T. Ries.

THE APPLE MAGGOT IN MICHIGAN

By DONALD T. RIES, *Michigan State College*

ABSTRACT

The Apple Maggot (*Rhagoletis pomonella* Walsh) has once more been causing severe losses in Michigan after a dormancy of about a quarter of a century. The adults appear in July and are at large until near the end of August. The larvae leave the fruit soon after it falls to the ground and enter the ground to pupate. About one-third of these emerge in September forming a second brood of flies that oviposit in late winter apples. Others may possibly lie over in the soil two years before emerging.

The Apple Maggot or "railroad worm" (*Rhagoletis pomonella* Walsh) during the past few years, has again become a serious problem to the fruit-growers of Michigan, after an absence of about quarter of a century. The damage in 1925 was not confined to small isolated areas but was quite generally distributed thruout the apple-growing regions of the state. In 1926, however, the more serious ravages seemed to be confined to one or two localized areas.

This insect was first reported from Michigan by Prof. A. J. Cook as doing great damage to the apples in Shiawassee County in 1884. For a number of years it was recorded as causing a large amount of damage to the apple crop. About 1900 the ravages seemed to decrease and very little was heard or seen of the pest until 1924 when it again began causing losses, and in the following year, 1925, nearly all the orchards of the state were quite heavily infested with the maggot.

In 1925 work was started on the life history of this insect. This was continued and completed this year and the new facts found are presented in this paper.

In the fall of 1925 we found the flies present in large numbers in the orchards at Stockbridge, Michigan as late as the first week in September. These flies were ovipositing in the late winter apples. At picking time the apples showed no evidences of the maggots working within them, but when the fruit was taken from storage for the market the flesh was found to be tunnelled thruout by the maggots, making it unmarketable. What happened to the puparia that must have formed from the maggots in these apples we were not able to ascertain. Probably many perished thru drying up as moisture was found to be needed by them.

The adult flies were first observed emerging on July 13th this year. At that time only a few were found in the different orchards. The general emergence began on July 15th and the flies continued to be abundant until the 23rd of August. On September 27th a few adults were found crawling among the fallen apples beneath a Maiden Blush tree. The weather was too cold for them to take flight and infest the nearby winter apples. These were probably adults of the second generation which in some years would infest the winter apples.

The first oviposition was observed on August 2nd, but upon cutting into the fruit a number of very young larvae were found, indicating that oviposition started a number of days before. It seemed from observations made of caged specimens that it takes about two weeks after the adults emerge for the reproductive organs to reach maturity. The eggs are laid just beneath the surface of the skin in a small cavity that is made at an angle of about 45° by means of the ovipositor. A little over a minute was required for oviposition. When first made, the punctures are inconspicuous, but soon turn dark, leaving a small brown speck on the surface of the fruit. Most of the eggs are laid on the sides rather than on the ends of the fruit.

When the fruit begins to grow and enlarges in size these spots many times appear as dimples and are sometimes confused with the injury of the Apple Redbug, Aphids, or Apple Seed Chalcid.

The incubation period lasted from two to seven days in Michigan—depending upon the temperature and variety of the apple. In early apples, Yellow Transparent, Early Harvest, etc., the eggs hatched in two or three days; while in later apples, McIntosh, Hubbardston, Grimes Golden, etc., six or seven days were required. The length of the larval period also seemed to vary with the variety of the apple; 13 to 15 days in Yellow Transparent, while in Pound Sweets 27 days were required to complete the larval period. Eggs deposited in Stark's Delicious on August 23rd were examined on October 9th and only very small larvae were found. None had as yet left the fruit. On November first the larvae were about half grown.

In most cases the presence of the maggots causes the fruit to ripen prematurely, drop to the ground and decay. This was not true, however, in the case of Greasy Pippins, which were found heavily infested and the emergence holes of the larvae were found in the sides of the decaying apples still hanging on the tree.

Soon after the fruit drops to the ground, the larvae leave and enter the soil where pupation takes place. Several writers advocated picking up the "drops" twice a week in an attempt to keep a large portion of

the larvae from going into the soil. This method, however, did not prove effective this past season in Michigan. In the case of several trees of Early Harvest Apples the orchard was visited on Tuesday, at which time 178 apples were picked up. These apples had fallen since late Sunday afternoon. Of these 178 apples, 163 were found to contain either maggots or evidences of maggots having been present, and 125 of this latter number contained exit holes of the maggots, so it would seem that the larvae had left the fruit very soon after the fruit had reached the ground as there were no exit holes found in the apples still remaining on the tree. It was also found that some of the maggots may pupate in the tunnels within the fruit.

It was thought that the maggots that entered the ground this year remained there over the winter and emerged the following spring. On August 3rd two cages were "made up," one in the greenhouse and one out doors, containing a number of Yellow Transparent apples. On September 19th, 2 males emerged from the material in the greenhouse cage and two days later, September 21st, several males and females emerged from the cage out doors. Adults continued to emerge from these cages until October 9th. It seemed that about one-third emerged to form the second generation.

It also seems probable that some of the puparia lie over for two years instead of emerging the following spring. The reason for suspecting this is the fact that in one orchard there was a heavy infestation in 1924. In 1925 the flies were again plentiful, but the orchard was very carefully sprayed and all the "drops" picked up daily and completely disposed of by burying in a deep hole that was treated with kerosene and lime before it was closed up; yet in 1926 we again found quite a heavy infestation that probably came from the orchard itself as it was isolated from others and from observations made this past season the adult flies do not seem to fly a very great distance.

FIRST VICE-PRESIDENT C. J. DRAKE: The next paper is by P. J. Parrott.

THE PEACH COTTONY SCALE

By P. J. PARROTT and S. W. HARMAN

ABSTRACT

The resistance of the peach cottony scale (*Pulvinaria amygdali* ?) to common sulfide sprays prompted efforts to determine the susceptibility of the insect to oil sprays. Tests demonstrated the possibility of securing satisfactory commercial

control with various oil preparations applied in the spring as the buds were swelling as well as with midsummer applications of "white oil emulsions" directed against "crawlers" and young scales. It is noted that plantings receiving either two or three treatments with "white oil emulsions" for two successive years have so far shown no indications of injury to the health of the trees.

During the summer of 1925 peach growers were thrown into a flutter on account of the appearance in their plantings in considerable numbers of an unfamiliar scale insect. A survey of the area of infestation showed that the species was most conspicuous in peach orchards within a range of 5 to 7 miles of the shore of Lake Ontario in Wayne, Monroe, Orleans, and Niagara counties. In view of the conspicuous infestation of certain orchards and the resulting perturbation among growers, it is worthy of note that, with one possible exception, the pest if present on the trees during 1924, and it surely must have been, completely escaped the attention of orchardists and county and state officials in the agricultural service. With this fact in mind it is not hard to picture the surprise of all those who were in any way concerned with the welfare of the peach industry as they reflected on the widespread distribution and the all too obvious destructive capacities of an apparently unknown insect.

On the assumption that a new pest was involved questions which naturally suggested themselves were: "What was the native habitat of the pest? How did it find its way to this area? What was the history of the species in the fruit region prior to its discovery? What was the most practical method of saving the peach crop already showing evidences of serious smutting?" To these questions there were no definite answers—only surmises. Superficial observations of the insect indicated a close similarity to the maple cottony scale, *Pulvinaria vitis*, but one's confidence in such a diagnosis was rudely jarred by a subsequent survey of the infested region which revealed that, while several maple trees showed a few specimens of this scale, maples generally were free of infestation. In marked contrast to the condition of maples one experienced little difficulty in finding infested peach orchards in the area described, and since it seemed to meet practical needs the insect was therefore tentatively designated as the "peach cottony scale." Coming as it were over night, such was the problem presented to us for solution.

THE IDENTITY OF THE PEACH COTTONY SCALE. It was obviously desirable to have the species correctly identified and, accordingly, specimens were forwarded to systematists specializing in this group of insects. At present the determination of the scale is still uncertain. It has been identified as *Pulvinaria amygdali*, previously reported on peach from New Mexico; on plum from South Carolina, Georgia, and

California; and on prune from California. Likewise, the insect has been classified as *Pulvinaria vitis* which, as is generally known, is our common maple cottony scale reported to have a wide range of host plants, including the peach. Specimens of *amygdali* from Georgia and California show differences from the form occurring on peach trees in New York which make us think that a different species is involved. On the other hand, the insect more nearly resembles *vitis*. If not this species, our form is apparently closely related to it. The systematists are devoting their attention to this aspect of the problem.

Host Plants. The cottony scale occurs commonly on peach trees. It has also been observed in goodly numbers on quinces, plums, and prunes. Apparently the pest thrives on all three hosts, notably quinces, which in some instances were as heavily incrusted as peach trees. Apple and pear foliage in close proximity to peach plantings frequently showed large numbers of "crawlers" and young scales, but, generally speaking, the insect seems to have found it difficult to establish itself on these plants. Several reports were current that the scale was observed on grape and woodbine, but no cases of infestation were brought to our attention. While the pest breeds freely on several peach varieties, it is deserving of note that a surprisingly large number of failures characterized our attempts to colonize the larvae on a variety of peach different from the one from which they had been transferred.

Life History. The life and habits of the peach cottony scale correspond closely with those recorded for *P. vitis*. The number of eggs varied with individual scales, apparently due in part to differences in the maturity of the creatures, and ranged from 800 to as high as 3,000 and upwards per insect. Because of the interest in white oil emulsions which were used effectively against the crawlers and young scales, as will be considered later, it should be noted that during 1925 the eggs began to hatch by the middle of June and that hatching was apparently completed by the first of July. The season of 1926 was at least two weeks behind the 1925 season, due to a late spring and cool summer, and hatching did not start until July 1 and was concluded on July 27. Making some allowance for differences in seasonal conditions, the period of these activities is quite similar for that reported previously for *vitis* from both New York and Ohio.

Nature of Injury to Peaches. Plantings which show noticeable infestation usually display lack of vigor, due to the weakening and unseasonable shedding of the leaves and the occurrence of dead twigs and branches. Another source of loss which is perhaps more keenly felt by growers than the depleted state of health of the trees, since it is so

obviously connected with the season's financial returns from the orchard, is the smutting of peach fruits. Blackened peaches become increasingly difficult to market at satisfactory prices when once the true nature of their discoloration is generally understood by fruit buyers. In packing peaches for the higher grades the specifications require the rejection of all smutted specimens, in consequence of which there may be considerable disparity between the yield of the orchard and the volume of marketable fruit.

A NATURAL ENEMY. A common parasite of the peach cottony scale is the hymenopteron, *Coccophagus lecanii*, which was kindly identified by Mr. S. A. Rohwer, U. S. Bureau of Entomology. The effective work of this parasite, coupled with the high mortality of the hibernating forms, seems to warrant the opinion that the cottony scale will not prove to be a permanent pest of primary importance.

CONTROL OF SCALE WITH OIL EMULSIONS. Lubricating oil emulsions (cooked and cold mixed) and proprietary miscible oils, diluted with water to give an oil content of 4 per cent, have afforded efficient protection. Fall applications appear to be as effective as spring treatments. In contrast with the oil sprays, lime-sulfur 1 to 8 was noticeably inferior. No injury was observed from oil mixtures of the foregoing strength when the applications were made during the period when buds began to swell and before the green tips showed, providing freezing weather was avoided.

Also, the scale proved susceptible to summer applications of commercial white oil emulsions (Volck and Medina) containing 2 per cent oil, and to home-made "white oil emulsions" containing "white mineral" oil and "Petrolatum Medium" (Nujol). The eggs were resistant to mixtures containing not more than 2 per cent oil.

"Crawlers" and young scales were very susceptible to these preparations. On account of the interference of the foliage careful spraying is required in the summer treatment, special pains being exercised to reach the scales on the under sides of the leaves. Effective control of the pest was secured in severely infested orchards with two applications, the first treatment being made when the "crawlers" first made their appearance, and the second treatment at the conclusion of the hatching period. Two applications of the "white oil emulsions," commercial or home-made, have apparently caused no injury to the trees. Moreover, one planting receiving three such treatments in 1925 and two applications during 1926 has so far revealed no ill effects. What the ultimate result will be from repeated treatments over a period of years is a matter for the future to determine. So far, the "white oil emulsions" have proved to be the only oil sprays that were safe to peach foliage. Injuries to

leaves occurred only when white oil emulsions were used in combination with copper or sulfur compounds or when they were applied to trees that had been previously treated with sulfur mixtures.

FIRST VICE-PRESIDENT C. J. DRAKE: We will now listen to a paper by Alfred Weed.

METAMORPHOSIS AND REPRODUCTION IN APTEROUS FORMS OF *MYZUS PERSICAE* SULZER AS INFLUENCED BY TEMPERATURE AND HUMIDITY[1]

By ALFRED WEED,[2] *University of Wisconsin*

ABSTRACT

Life history studies of the species have been carried in a series of controlled chambers in which the temperature and humidity have been constant. Interesting data has been accumulated with reference to length of instars, longevity and fecundity as inhibited or stimulated by a prescribed environment. The retardant influence of low temperature and humidity on the rate of development and reproduction of the species, together with the corresponding acceleration, which increases in these factors of the environment bring forth, are clearly indicated in the tabular and graphical presentation of the results.

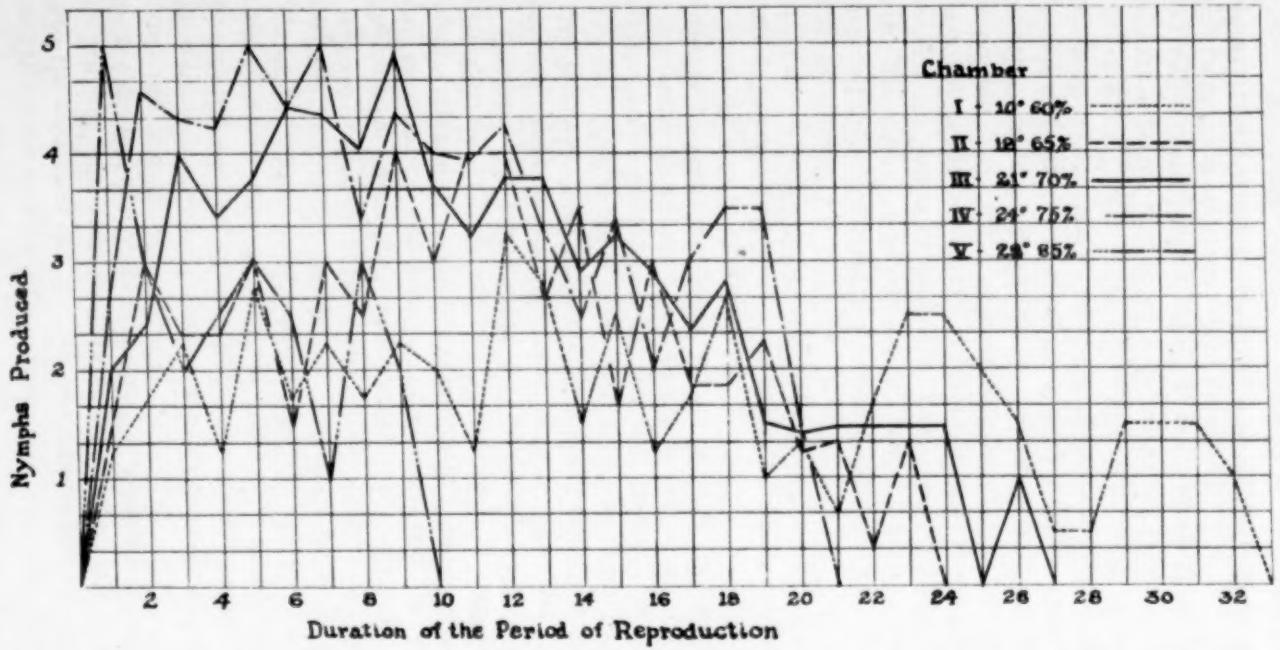
INTRODUCTION. In the field of biological science the restrictions placed upon living organisms, both plant and animal by environmental factors are obvious. These factors are ever present, and change both in quality and quantity from day to day, with a correlated response in the organisms. The character of the response depends upon the extent and degree of change of the environmental factors, and the susceptibility of the individuals under observations. Temperature and humidity are both important, because of the influence they exert upon metabolism and the physico-chemical phenomena of life.

The data presented represents the study of some three hundred individuals carried thru the winters of 1925 and 1926 in the greenhouse, as well as in chambers in which the temperature and humidity were maintained constant. Life history studies on apterous individuals supplied the data; and under the environmental conditions provided these forms continued as a constant, altho the species was subject to variations in temperature of eighteen degrees Centigrade (from 10°–28°) and twenty-five per cent relative humidity (from 60%–85%).

THE NATURE OF THE CHAMBERS. Conditions in the greenhouse were

[1]Contribution from the Department of Economic Entomology.

[2]Thanks are extended to Doctor J. G. Dickson for the use of the controlled chambers in which the studies were conducted.



The Reproductive Behavior of the Individuals Reared in the Series of Chambers Computed on Average Daily Nymphal Production and the Period of Reproduction.

Fig. 6

somewhat comparable to those out-of-doors; but the variations never reached the maximum or minimum temperature and humidity common in the field. The average temperature in the greenhouse, given in the tables as Chamber No. 3, approximated 21° Centigrade and the relative humidity ran at 70%.

The controlled chambers,[3] which were used in connection with the life history studies, consisted of large glass compartments, situated in separate sections of one of the (Plant Pathology) greenhouses. A cooling system of sulfur dioxide and brine, electric heating units, and humidifying equipment maintained uniformity in both temperature and humidity. The conditions maintained within the chambers were approximated in the compartments housing them. Hygrothermographic records, taken within the chambers denoted the changes to be made in the control apparatus. Average conditions in these chambers ran as follows: Chamber I, temperature 10° Centigrade, relative humidity 60%; Chamber II, temperature 16°, humidity 65%; Chamber III (greenhouse), temperature 21°, humidity 70%; Chamber IV, temperature 24°, humidity 75%; Chamber V, temperature 28°, humidity 85%.

METHODS. Two types of cages were employed in conducting the life history studies; standard battery jars, and ordinary lamp chimneys. With the cages mentioned, large-mouthed bottles of convenient size were used to provide an adequate supply of water for leaves of spinach upon which the aphids were reared.

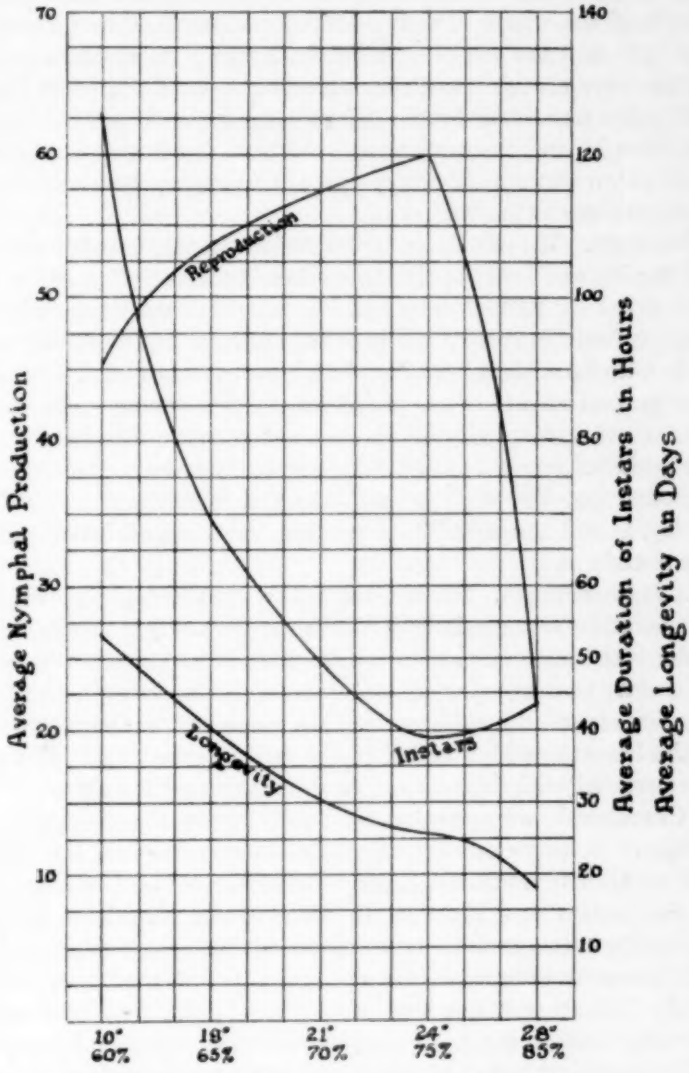
In the greenhouse both types of cages were used, but in the controlled chambers where limitations of space were incurred, only the latter type of cage was employed.

Blackened metal discs, several inches in diameter and provided with a central perforation to accommodate the plant stems, were fitted into the necks of the bottles in the battery jars. These discs facilitated both the recording of the cast skins and prevented individuals from dropping to the bottom of the cage. The central perforation was plugged with cotton after the leaf was in place. This prevented the drowning of individuals and the loss of nymphal skins. A cheese cloth cover, held in place with rubber bands, completed the structure of the cage.

The "chimney" cages were essentially the same, except that the globes were inverted and fitted with cardboard bottoms. The wide-mouth bottles were held upright by surrounding them with cotton wadding; and black cardboard discs were used.

The individuals under observation were maintained on fresh leaves

[3]Dickson, J. G. Making Weather to Order for the Study of Grain Diseases, Wisc. Agr. Exp. Sta. Bull. 379, 1926.



Curves Illustrating the Influence of Temperature and Humidity on Reproduction, the Length of Instars and Longevity in Myzus persicae Sulzer.

Fig. 7

of spinach, cut under water, to prevent air from entering the conductive vessels of the stems. Fresh material was supplied at forty-eight hour intervals; and the stems were cut back every twenty-four hours. The aphids were always handled with extreme care, transfers being made with a fine camel hair brush. Observations were made twice daily upon the nymphs and the adults; and the first and last born nymphs were reared thru to maturity; they and their progeny being employed for a continuation of the studies.

RESULTS. The results are illustrated in the tables and the accompanying graphs; and indicate the differences in the activities of the species as stimulated by temperature and humidity. That these differences are restricted within certain limits of temperature and humidity is obvious, for in one of the Chambers (V), the individuals showed signs of inhibition. The general effects of these factors on reproduction, the duration of instars and on longevity, as characteristic for the chambers are shown in the series of curves. (Fig. 7.) In plotting the curves, the average reproduction, the average length of the instars and the average longevity, for all the individuals studied, have been taken for each of the five chambers.

METAMORPHOSIS. These results show that metamorphosis is directly influenced by changes in temperature and humidity. Individuals reared under identical conditions, even from the same parent, responded quite differently to the environmental conditions. An examination of Table 1, showing stages in metamorphosis indicates clearly the retardant nature of the lowest chamber and that the gradual speeding up of this process is correlated with increase in temperature and humidity. Conditions in Chamber V were apparently inhibitory to the development of the species. In this chamber difficulty was experienced in carrying individuals thru to maturity. Altho the maximum and minimum duration of the instars was identical in some of the chambers, computations giving the averages show a diminution in the lapse of time between molts with increases in temperature and humidity. A shortening in the length of the immature stages and a decrease in the time element between maturity and the production of the first nymphs is shown.

The averages assumed are based upon computations for the entire number of individuals reared under the various conditions of environment, and no consideration is given to the generations concerned. However, it may be stated that all the results computed begin with the 2nd filial generation.

REPRODUCTION. Reproduction, like metamorphosis, is also influenced by changes in temperature and humidity. An increase in the nymphal

production is seen in the chambers in which the temperature and humidity were high. Considerable variation is incurred when the maximum and minimum nymphs per individual are examined. This acceleration of reproduction is evidenced in the average total nymphs produced and in the daily averages based upon both the reproductive period and adult longevity. Certain forms in Chambers II and III appear subnormal with reference to their reproductive ability and may possibly have been injured to some degree; but a correction was not made because their longevity was comparable to others under the same conditions. As in the metamorphic stages, Chamber V, exhibited its retardant effects upon reproduction.

Figure 6, illustrates the average daily reproduction computed for the total number of individuals in each chamber. It is interesting to note that the maximum period of reproduction by individuals was reached first under conditions of higher temperature and increased humidity. In Chamber V, temperature 28°, humidity 85%, this is reached the first day, after which reproduction decreases. In Chamber IV, temperature 24°, humidity 75%, the peak extends from the fifth to the seventh day; while in Chamber III, temperature 21°, humidity 70%, it is reached on the ninth day. In Chamber (II), temperature 16°, humidity 65%, it appears from the ninth to the twelfth day, whereas in Chamber I, temperature 10°, humidity 60%, the peak is reached on the twelfth day.

Reproductive Period and Longevity. The reproductive, nymphal, and adult period, and the total period of longevity indicate the reverse effect of temperature and humidity. A decrease in these stages of the life cycle is associated with increases in the factors under consideration. The average reproductive period drops from twenty-five and one-fourth days in Chamber I, to seven days in Chamber V. The latter chamber plainly inhibits the development of the species. The average total longevity of the species in Chamber I is nearly sixty days. This falls to less than eighteen in Chamber V. Nymphal and adult longevity periods indicate parallel diminutions in the time factor with increases in temperature and humidity.

Conclusions. There is a definite response in *Myzus persicae* Sulz. to changes in temperature and humidity. An increase or decrease in temperature and humidity acts as a stimulus. Increased activity is brought about by rises in temperature and humidity but when temperatures near 28° and humidity near 85% are reached, inhibition occurs. The converse occurs with extreme low ranges.

With an increase in temperature and humidity there is an increase in the rapidity of growth, and a speeding up of the process of repro-

TABLE 1. METAMORPHOSIS

Chamber	Individuals	Hours between birth and 1st molt			Hours between 1st and 2nd molts			Hours between 2nd and 3rd molts			Hours between 3rd and 4th molts			Hours between birth and maturity			Length of instars in hours			Hours between maturity and prod. of 1st nymphs		
		Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.
I 10°-60%	16	192	48	126.00	144	96	120.00	144	120	126.00	168	120	129.00	624	456	501.00	192	48	125.25	144	48	86.40
II 16°-65%	22	96	48	75.27	96	48	67.63	120	48	60.00	120	48	70.90	360	192	273.80	120	48	68.45	72	12	34.66
III 21°-70%	138	72	24	47.44	72	24	49.21	72	24	48.34	72	24	54.96	240	144	199.95	72	24	49.98	72	12	27.15
IV 24°-75%	67	72	24	39.04	72	24	38.33	72	24	34.03	72	24	44.42	192	120	155.82	72	24	38.95	48	12	22.00
V 28°-85%	8	48	24	36.00	48	48	48.00	48	24	36.00	72	48	54.00	192	168	174.00	72	24	43.50	48	12	24.00

TABLE 2. REPRODUCTION AND LONGEVITY

Chamber	Individuals	Actual reproduct. Period in days			Young produced daily Average based on Reproductive period	Young produced daily Average based on Adult longevity	Total			Nymphal			Longevity in days Adult			Total		
		Aver.	Max.	Min.			Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.
I 10°-60%	12	25.25	32	17	1.79	1.45	5	1	45.25	57	36	21.66	26	19	31.25	41	26	52.91	61	46
II 16°-65%	18	20.50	26	15	2.62	1.88	8	1	53.83	83	16	12.10	15	8	28.50	41	19	40.60	53	31
III 21°-70%	36	17.66	24	10	3.23	2.56	10	1	57.11	85	18	8.38	10	6	22.28	41	11	30.66	48	19
IV 24°-75%	24	16.00	20	12	3.72	3.00	10	1	59.62	75	40	6.23	8	5	19.87	30	13	26.00	37	20
V 28°-85%	12	7	9	5	3.07	1.95	8	1	21.5	37	6	7.33	8	7	10.50	14	8	17.83	20	14

duction. With these conditions the greatest number of individuals are produced, not only on a daily basis but also for the life of the individual and the time requirement for the newly born nymph to reach maturity is materially lessened.

With a diminution of temperature and humidity, reproduction is inhibited and the rapidity of metamorphosis is reduced. Also, reproduction persists for a greater duration of time and the individuals live considerably longer.

It appears from the data that in *Myzus persicae* Sulz. the processes of metamorphosis, reproduction and longevity are proportional to temperature and humidity. An increase in reproduction and diminutions in the length of nymphal instars and longevity are correlated with increases in temperature and humidity, and the reverse is quite apparent with decreases in these environmental factors. This of course applies only within those ranges of temperature and humidity which are not harmful to the species.

FIRST VICE-PRESIDENT C. J. DRAKE: The next paper is by E. D. Ball, B. L. Boyden, W. E. Stone and J. E. Reeves. Dr. Ball will read the paper.

BIOLOGICAL FACTORS IN THE CONTROL OF THE CELERY LEAF TYER

By E. D. BALL, B. L. BOYDEN, W. E. STONE and J. E. REEVES, *Sanford, Florida.*

(Withdrawn for publication elsewhere)

MR. G. W. HERRICK: I would like to ask Dr. Ball if he determined the number of caterpillars any one bird will eat.

MR. E. D. BALL: No I did not. The moths flying out of the celery would be caught by the birds so the caterpillar crop fell down to the minimum. The birds would sit on the boxes where the harvesters were getting ready to harvest the celery and every time a moth appeared above the level of the celery it was gone.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by T. J. Headlee.

AN OPERATION IN PRACTICAL CONTROL OF CODLING MOTH IN A HEAVILY INFESTED DISTRICT[1]

By THOMAS J. HEADLEE, Ph.D., *Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

This paper gives the results of one year's effort against the codling moth, *Carpocapsa pomonella*, carried out by a group of eleven growers associated for that purpose and cooperating with the entomologist of the New Jersey Agricultural Experiment Station and shows: (1) that under codling moth infestation conditions, indicated by the fact that the late fruit in the check orchard averaged five injuries per apple, 73,850 bearing apple trees, covering 1,376 acres of orchard land, produced 280,200 bushels of fruit of which 192,320 bushels, or 68.8%, were absolutely free from all codling moth injury; (2) that this percentage of 68.8 represents a 20.5% increase in fruit absolutely free from codling moth injury over the conditions obtaining the previous year; (3) that the maximum amount of fruit absolutely free from codling moth injury at picking time obtained on any one of these properties was 97%; (4) that the principal factors underlying this accomplishment were more timely and accurate spray applications and the more intelligent and careful use of orchard sanitation measures, such as scraping the rough bark from the tree, the utilization of burlap bands and the partial or complete elimination of the used containers as a source of codling moth infestation. The conclusions are: (1) that, under the local conditions of heavy infestation of codling moth, this insect can be suppressed by intensive work against it; (2) that the most intensive part of the effort is the cover spray program against the entering larvae of the first brood; (3) that, where the insect has been suppressed, a very high percentage of the picked fruit can be brought through absolutely free from codling moth injury by intensive work against the first brood only.

Codling moth in a certain district of New Jersey has shown in the past thirteen or fourteen years a very great increase in destructive power. In fact, at the close of 1925 it had reached a point where some growers were beginning to believe that it could not be brought under control by any practicable means. This being the case it seemed well to attack the problem in this worst infested district.

CAUSES OF INCREASE. The reasons underlying this increase in infestation are more or less obvious to anyone who makes a study of the problem. First of all, for some unknown reason, parasites of the codling moth have in that district reached a very low stage of efficiency. In the second place the habit of storing used baskets in buildings, either in or nearby the orchard, has obtained for a number of years. In these used baskets large numbers of codling moth larvae have spun up and from them the adults have emerged each spring. In the third place the

[1]Paper No. 334 of the Journal Series of the New Jersey Agricultural Experiment Stations, Department of Entomology.

orchards in this district have come into bearing slowly, probably due to the lack of proper pollinizing. The crops were small and were not economically worth adequate treatment but still sufficiently large to offer the codling moth an abundance of food on which to grow and increase.

Be the causes of increase whatever they may, the moth several years ago had reached the point where it was capable of destroying every example of late fruit borne by unsprayed trees and capable, under the methods of treatment obtaining, of infesting entirely too large a percentage of the fruit borne by treated trees.

ORGANIZATION FORMED. Early last spring an organization of eleven growers was formed for the purpose of seeing what could be done toward reducing codling moth damage in this the Glassboro district. The Experiment Station representative agreed to specify when to treat, what to treat with, and how to treat. The growers agreed to equip themselves and carry out these directions to the best of their ability. Since this effort under this organization covered more than one thousand acres of bearing fruit in the worst infested section of the Glassboro district, it was felt by the Experiment Station that much time and trouble would be justified in carrying out this plan.

Accordingly, starting with the first sprays, the entomologist, with the exception of two or three occasions, visited each orchard property included within the group once each week throughout the season until about the middle of August, when the treatment effort had obviously come to an end.

TREATMENTS ADVISED. The treatments advised during the season covered: (1) the scraping of all old rough-barked trees in such a fashion as to clean off the rough bark and the application and working of burlap bands; (2) the removal or adequate treatment of used baskets normally placed in storage within or adjacent to these properties; (3) a spray schedule consisting of delayed dormant, pink bud, blossom fall, seven day after blossom fall, intensive cover sprays during the period of entry by the worms of the first brood of codling moth and a small number of cover sprays during the period of entry by worms of the second brood. In this instance the scarcity of apple aphis eggs and the abundance of European red mite eggs led to the use of a delayed dormant spray consisting of oil emulsion. The pink bud spray consisted of the same materials usually recommended, namely, commercial lime sulfur and lead arsenate. The blossom fall spray consisted of dry-mix and lead arsenate according to the usual formula. The seven day after blossom

TABLE 1. RECORD OF CODLING MOTH CONTROL IN 1926

CONCERNS THE PROPERTIES OF GROWERS ASSOCIATED FOR CONTROL OF CODLING MOTH AT GLASSBORO

Orchard number	Acreage	No. of trees	Size of trees height x width in feet	Per cent fruit Early	Per cent fruit Late	Number of sprays Early Total	Number of sprays Early Codling moth	Number of sprays Late Total	Number of sprays Late Codling moth	Average number of gallons per tree per treatment	Scraping Needed	Scraping Used	Banding Needed	Banding Used	Yield in bushels	Per cent free from codling moth injury 1925	1926	Gain
1	80	2,400	20 x 25	35	65	6	3	8	5	8	Yes	Late Yes Early No		Late Yes Early No	28,000	50	75	25
1A	130	7,000	20 x 25	7	93			7	4	8	Yes	No	Yes	No	13,000	55	50	—5
2	25	700	25 x 30					7	4	8	Yes	No	Yes	No	6,000	25	40	15
2A	25	700	12 x 14		100			9	6	3	No	No	?	Yes	4,000	40	85	45
3	100	5,000	20 x 25		100			9	6	9	Yes	No	Yes	Yes	65,000	45	60	15
3A	30	1,500	20 x 25		99			7	4	3.6	Yes	No	Yes	Yes	15,000	50	75	25
3B	15	800	25 x 30					7	4	5?	Yes	No	Yes	No	5,000	00?	85	85
4	35	2,000	16 x 18	10	90			9	6	5	Yes	No	Yes	Part.	6,000	40	70	30
5	15	1,200	12 x 14	13	87	2	1	9	6	2¾	No	No	Yes	Yes	4,000	45	85	40
6	60	3,000	20 x 25	20	80	6	3	8	5	3	Yes	No	Yes	No	12,000	60	85	25
7	15	900	16 x 20	10	90	4	2	8	5	4	No	No	Yes	Yes	3,200	60	90	30
8	400	15,000	20 x 25	25	75	6	3	8	5	7	Yes	Late yes	Yes	Yes	55,000	35	50	15
9	80	3,850	20 x 25	20	80	6	3	8	5	7	Yes	No	Yes	No	14,000	39	75	36
10	40	1,800	22 x 28	5	95	6	3	8	5	5.0	Yes	Yes	Yes	Yes	10,000	75	80	5
10A	50	3,000	25 x 30	25	75	6	3	8	5	6.6	Yes	Yes	Yes	Yes	23,000	80	95	15
11	276	25,000	10 x 12		100			7	4	2.5	No	No	No	No	17,000	60	97	37
Totals	1376	73,850													280,200			

Note:—Check orchard was sprayed according to its owner's judgment. Some clean fruit came from early varieties. Late varieties averaged 5 stings per apple. Orchards Nos. 1A and 2 were admittedly very inadequate from the standpoint of time of application.

fall spray consisted of the same material. The cover sprays for the first brood side worms consisted of dry-mix with powdered lead arsenate at the rate of two pounds to fifty gallons or its equivalent and enough additional sticker to make a total of three pounds to one hundred gallons, and the cover spray of the second brood consisted of a reduced amount of dry-mix, no additional sticker and lead arsenate with the usual strength of one and one-half pounds of the powder to fifty gallons. The timing of the cover sprays was made through the agency of the codling moth emergence cages and codling moth bait pans. As soon as the cover spray stage was reached it was insisted by the entomologist that the sprays should result in a film coating of fruit and foliage and that they should be repeated with sufficient frequency to insure the maintenance of this coating. Of course, on early fruit fewer cover sprays were given, and these without additional sticker, than the number given to late fruit for the same stage of the codling moth. All spraying was stopped the middle of August.

RESULTS OF TREATMENT. The results of the effort are set forth in three tables which are self-explanatory.

TABLE 2. RECORD OF YIELDS UNDER TREATMENT FOR CODLING MOTH CONTROL 1926 CONCERNS THE PROPERTIES OF GROWERS ASSOCIATED FOR CONTROL OF CODLING MOTH AT GLASSBORO

Orchard numbers	Yield in bushels Total	Fruit free from codling moth Bushels	Per cent	Gain in 1926 fruit free from codling moth as compared with 1925 Per cent	Bushels
1	28,000	21,000		25	7,000
1A	13,000	6,500		—5	—650
2	6,000	2,400		15	900
2A	4,000	3,400		45	1,800
3	65,000	39,000		15	9,750
3A	15,000	11,250		25	3,750
3B	5,000	4,250		85	4,250
4	6,000	4,200		30	1,800
5	4,000	3,400		40	1,600
6	12,000	10,200		25	3,000
7	3,200	2,880		30	960
8	55,000	27,500		15	8,250
9	14,000	10,500		36	5,040
10	10,000	8,000		5	500
10A	23,000	21,850		15	3,450
11	17,000	16,490		37	6,290
Totals	280,200	192,820	68.8	20.5	57,690
Note:—Removing orchards Nos. 1A and 2 from consideration because they are clearly and definitely inadequately treated we have the following results:					
	266,200	195,420	73.4	25.2	67,190

TABLE 3. BRIEF GENERAL SUMMARY OF CODLING MOTH CONTROL IN 1926 CONCERNS THE PROPERTIES OF GROWERS ASSOCIATED FOR CONTROL OF CODLING MOTH AT GLASSBORO

A. Including all orchards regardless of treatment obtained	
No. of orchard properties under treatment	11
Acreage	1,376
No. of bearing apple trees involved	73,850
Total yield in bushels	280,200
Bushels free from all codling moth injury	192,820
Bushels gain in clean fruit over 1925	57,690
Average percentage absolutely free from all codling moth injury	68.8
Percentage gain in freedom from injury in 1926	20.5
Maximum percentage freedom from injury	97.0
Minimum percentage freedom from injury	40.0
B. Excluding orchards Nos. 1A and 2 because of admittedly inadequate treatment	
No. of orchard properties under treatment	11
Acreage	1,221
No. of bearing apple trees involved	66,150
Total yield in bushels	261,200
Bushels free from all codling moth injury	183,920
Bushels gain in clean fruit in 1926	57,940
Average percentage free from codling moth injury	70.4
Percentage gain in freedom from injury in 1926	22.1
Maximum percentage freedom from injury	97.0
Minimum percentage freedom from injury	50.0

COST OF THE OPERATION. As in many cases of this sort it has proven difficult to secure reliable cost figures but, as nearly as it could be determined, the total cost of the treatment operations, including scraping and banding, care of used containers, and spraying operations is about $70,000.00 or $50.80 an acre or $.27 a bushel. Of course the acre and bushel costs are average.

DISCUSSION. The comparative value of heavy spraying and care of used containers was rather well illustrated in a part of orchard No. 9. Standing on the edge of this orchard block was an open shed storehouse in which had been placed, during the preceding dormant season, about 40,000 used bushel hampers. It was impractical for the grower either to make this building moth tight or to treat or remove the baskets. It was, therefore, suggested to him that he keep the first ten rows adjacent to this storehouse heavily coated with spray materials during the period of entry by codling moth larvae of the first brood. This suggestion was pretty faithfully followed out. In spite of the fact that an enormous number of moths emerged from these used containers, as shown by the projecting pupal shells, at the close of the season fully

30% of the late fruit borne by trees immediately adjacent to the storage shed was absolutely free from all types of codling moth injury. The infestation of moths among the trees adjacent to this storage shed was extremely dense, yet very thorough spraying served to bring through fully 30%.

The study of the relation of scraping and banding to clean fruit, as set forth in Table No. 1, does not give definite results because a variation in the efficiency of the spray applications seems more than able to overcome the effect of scraping and banding. In orchard No. 3 the effect of incomplete use of these measures seems more prominent than in any other planting. This orchard was composed of large trees which yielded an average of a little better than twelve bushels each. In that section of this orchard where neither scraping nor banding was used, although the spraying given was apparently fully equal to that given in other parts of the orchard, the infestation was much heavier. In the carefully scraped and banded portion of this orchard the fruit free from all codling moth injury was easily 75%, while the sections not scraped and banded were wormy enough, when taken with a section in this same orchard later to be discussed, to pull down the average of the orchard to 60% fruit absolutely free from codling moth. In another section of orchard No. 3 there was a considerable number of early fruit trees which, because of the nature of the variety and the price obtaining for the same at picking time, were allowed largely to shed their fruit on the ground where it remained. In this section of the orchard the worm infestation was heavier than in any other part, although the spraying given it was fully equal to any other part. From these facts, the writer concludes that the failure to practice scraping and banding and to care for the early fruit, drops, and picks, resulted in a very greatly increased infestation, in spite of the character of the spraying done. Scraping and banding is, according to his point of view, an attempt to render the large rough-barked tree the practical equivalent, in point of a satisfactory place for the codling moth larvae to spin up, of the young smooth-barked tree. That scraping and banding in themselves, unaccompanied by satisfactory and complete spraying operations, are totally unable to control codling moth infestation is shown in the check orchard which was carefully scraped and banded but not satisfactorily sprayed, in which the late fruit showed an average of five worm holes per apple.

Movement of codling moth from untreated or unsuccessfully treated trees of bearing apple into the satisfactorily treated orchards results in an increase in infestation in that portion of the treated orchards

adjacent to this source of moths, as shown by the experience in orchard No. 11. The only worminess of any movement whatever in orchard No. 11 occurred at one end of the rectangular block of 276 acres standing adjacent to a small but old and uncared for orchard.

In an area very heavily infested with codling moth there seems to be two stages in the effort against it. The first is the stage of suppression or repression and requires far more intensive work than the one which follows. The second is the stage of codling moth control in which the infestation is not more than sufficient to infest 50% of the fruit on unsprayed trees in the orchard concerned. The difference is well illustrated by a comparison of orchard No. 11 with orchard No. 1. Orchard No. 11 in 1925, with a relatively limited amount of spraying, gave 60% fruit free from all codling moth injury. This orchard in 1926, with treatments designed to control the first brood only, gave 97% of the harvested fruit absolutely free from all codling moth injury. Orchard No. 11 represents the control phase of the codling moth problem. Orchard No. 1, which, under heavy spraying in 1925, gave 50% clean fruit, under very thorough spraying designed to control both broods in 1926 gave only 75% of the harvested fruit absolutely free from codling moth injury. Orchard No. 1 represents the suppression stage of the effort against codling moth.

It seems possible, where orchards are composed of trees easy to spray very thoroughly, and in which scraping and banding has been practiced, as needed, to obtain a remarkably large amount of the harvested fruit absolutely free from codling moth injury by the practice of very thorough spraying. Orchard No. 3B is an example of this condition. The owner and operator of orchard No. 3B told the writer that in 1925 he was sure that there was no fruit absolutely free from codling moth injury and that the whole crop was turned into cider; yet in 1926, in spite of the fact that a certain limited amount of scraping was necessary and was not done, very thorough treatment accompanied by thorough operation of the bands resulted in the harvesting of 85% of the fruit absolutely free from codling moth injury of all kinds. Judging from the 1926 experience in an organized effort against the codling moth in a district in which the moth is very abundant, the writer feels safe in saying that when the harvested fruit of the preceding year shows 90% absolutely free from codling moth injury of all kinds the codling moth suppressive effort has been completed and that control can be obtained by careful work designed to destroy the first brood only, except in cases

where this orchard is subject to heavy migrations from large adjacent plantings of uncared for bearing apple orchard.

The question of timing of the cover sprays for the destruction of codling moth in apple orchards where it is very abundant is somewhat different from the same question in which the codling moth infestation is comparatively light, say such as sufficient to produce not more than 50% worminess on unsprayed trees. In the first place determination of the time when the cover sprays should begin cannot be made in either type from the standpoint of tree development, as shown by the fact that this year the first cover spray for codling moth came at the time of our ordinary 17 day after blossom fall spray, instead of about 4 weeks after blossom fall, as is usually the case. The beginning of cover sprays for codling moth should, in the writer's experience, come when the moth appears in the orchard on the wing. Codling moth cages are inadequate for the purpose of determining this time because many different factors of difference between cage conditions and tree conditions enter in. It is possible that codling moth may begin to emerge in cages earlier than from the trees but, as a matter of fact, the reverse seems to be true. In view of this variation, it was felt that some other method must be used to determine the appearance of the moths in the orchard. For this purpose in 1926 the oriental peach moth bait pans were utilized. The pans were placed in the foliage wall of the tree, about half way between the top and bottom where, in previous years, the greatest number of fluttering moths had been observed. It seems that when the codling moth has emerged in the orchard, and the weather is such as to encourage it to lay eggs, pans placed in this position catch moths, thus telling the grower exactly when his enemy is abroad and when his danger time has arrived. A number of years experience has convinced the writer that the proper intensive spraying effort against the codling moth, under heavy infestation conditions, begins in time to have the cover on when the first worms start to enter and to keep it on during the entire period of entry. Spraying, therefore, should begin as soon as any considerable number of codling moths are caught in the bait pans and the film coating administered at that time should be kept by such replacement as may be necessary throughout the time that the moths continue to be caught in the bait pans. This year this effort involved three cover sprays for the first brood and two cover sprays for the second brood.

Further Plans. This effort represents the first of three years of work designed to reduce the codling moth to a point where 90% of

the picked fruit is entirely free. After this stage has been reached the insect can be controlled by the application of the regular schedule and intensive cover spraying for the first brood only.

MR. E. R. VAN LEEUWEN: I am very much interested in Dr. Headlee's report. I would like to ask if he thinks it is possible to conduct a clean-up campaign over a period of four or five years in such a way that the first brood can be controlled to the extent that there will be very little arsenic spraying done after the first few worms are found and probably solve this problem of arsenic remaining on fruit.

MR. T. J. HEADLEE: I would like to answer that question by saying "Yes if the man organizing the movement can keep the growers sold on the proposition." Orchard No. 11, 276 acres, with 60 per cent of the total picked fruit last year free from codling moth; this year treating for first brood only 97 per cent clean. There are now in this group two more orchards that are ready next year for first brood treatment only, and I believe they can handle the codling moth by that means in those two orchards. At any rate that will be the step taken in those two orchards. That will take three—the rest of the eight properties will come along on the same basis as this year.

MR. J. S. HOUSER: May I ask first if the emergence this year was normal; that is if the first brood was extended abnormally long. Secondly I would like to have your spraying schedule by which you accomplished that result.

MR. T. J. HEADLEE: The emergence brood spraying was perhaps a trifle longer than is normally the case. It certainly started considerably later than is normally the case. I will admit you to the secret that the second brood was chopped off a little earlier, all of which was in our favor.

The schedule is all outlined in the paper. It is our regular spraying schedule, with cutting such corners as the absence of certain insects and diseases permit us. The total cost of the whole operation, spray and orchard sanitation, was approximately $80,000. As you see, there are 73,850 trees in the entire project.

I rather hesitate to give the spraying schedule because of the time required.

MR. P. M. GILMER: I would like to ask Dr. Headlee if he thinks that adaptable where we have three full broods.

MR. T. J. HEADLEE: Of course it has been a long time since I worked in a three-brood area. I think our period of emergence of the moth in

the first brood was almost as long as the second or third. I don't know how to work the third-brood area. The only argument that a person can bring forward, of course, is that the first brood is apparently a parent to the second, and if you can kill the parent, you are not going to have many children.

FIRST VICE-PRESIDENT C. J. DRAKE: The next paper is by S. W. Frost.

FURTHER STUDIES OF BAITS FOR ORIENTAL FRUIT MOTH CONTROL[1]

By S. W. FROST

ABSTRACT

The relative attractiveness of various baits to the oriental fruit-moth, *Laspeyresia molesta*, is discussed. The results correlate very well with those made by the writer in 1925. The possibilities of weak acids, volatile oils or their ingredients, fermenting and non-fermenting baits are discussed. While fermenting baits give, on the whole, larger catches, the non-fermenting baits have a longer period of activity and may prove more practical for control purposes. The results clearly indicate that a more attractive bait must be had before adequate control can be expected. Orchard tests, where the infestation is not high, show a reduction of nearly 30% wormy fruit

During the season of 1926, the investigations of the previous summer were duplicated, enlarging the work considerably and increasing the number of test pails. Practically all the work was conducted in an orchard of Krummel peach trees near Arendtsville, Pa.

TESTS OF DIFFERENT TYPES OF BAITS

METHODS. The methods used during the current season simulated those of 1925 with the following changes (1) test pails were hung on every other tree in alternate rows, (2) at least five, and in some cases ten pails were used in testing different baits, (3) only number ten, tin pails, of approximately a gallon capacity, were used, (4) all pails, except a few used during the very first of the season, were painted, within and without, with white paint, (5) the pails were filled one-half full with bait and nothing was added during their operations except water to compensate for evaporation, (6) they were examined once a week, and the insects strained from them and taken to the laboratory for final examination, (7) all bait-tests were placed in the same block of krummel trees.

SEASONAL CONDITIONS. A few seasonal conditions should be taken into consideration in interpreting this paper. In general, the infestation

[1]Published by permission of the Director of the Agricultural Experiment Station as a part of Project No. 697. Contribution from the Department of Zoology and Entomology, The Pennsylvania State College, Technical Paper No. 416.

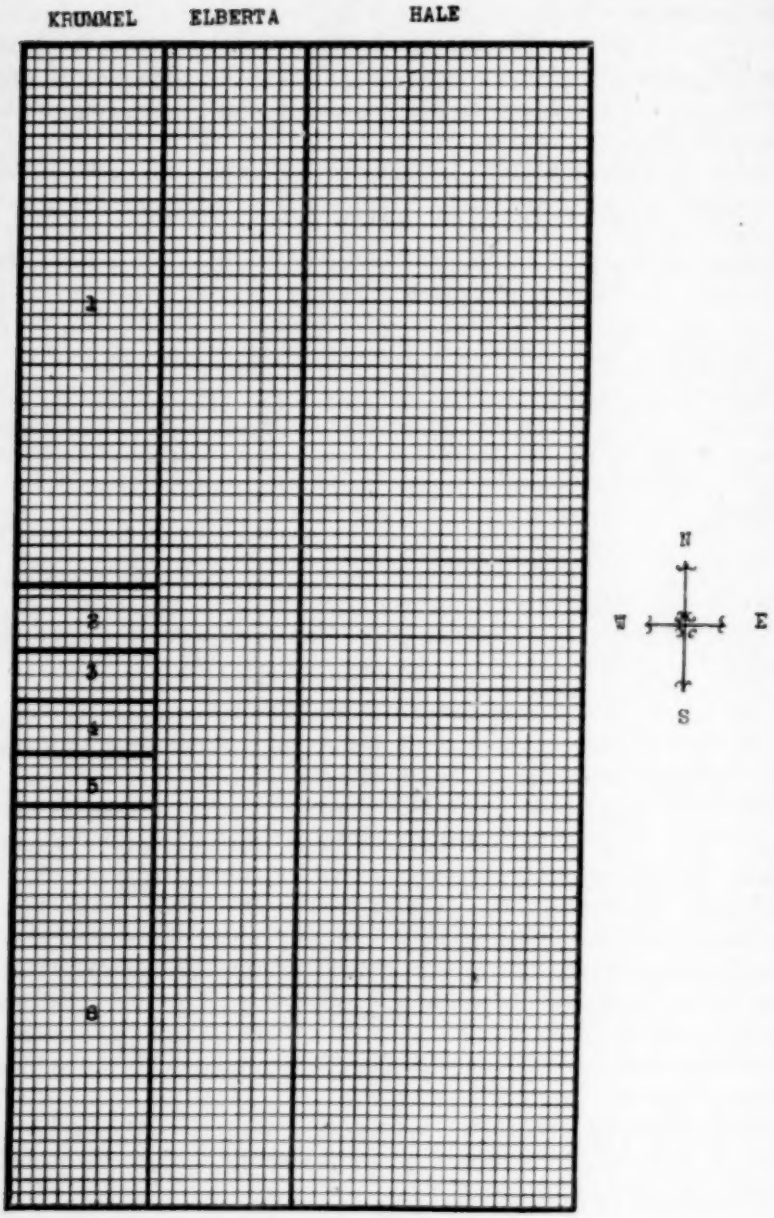
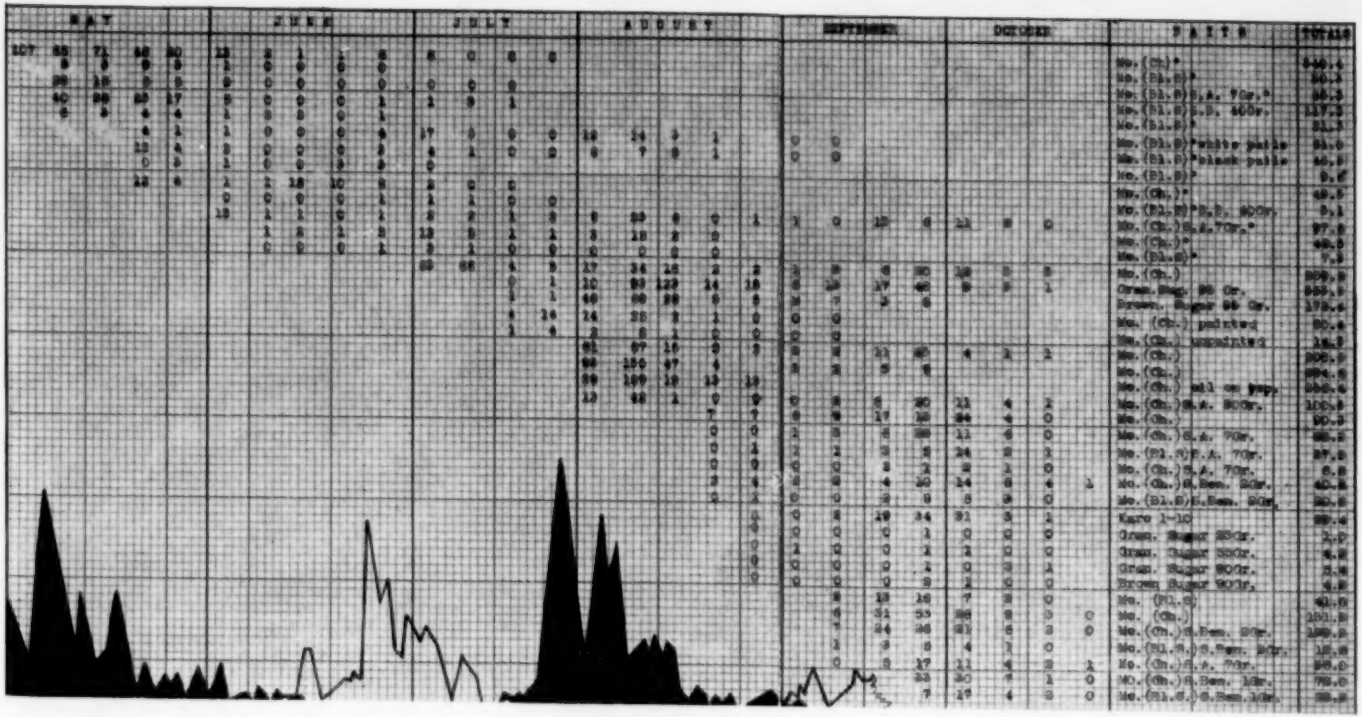


FIG. 8. A corner of the peach orchard showing location of pailed and unpailed blocks (each square represents a tree).



Weekly collections of oriental fruit moths from sugar baits. (All reduced to number of moths per pail, see explanation).

was not high and apparently lighter than the preceding season. The moths were not observed flying in appreciable numbers at any time during the summer, and twig injury was scarcely noticeable in the orchard where tests were conducted.

Between May 5th and 11th, the catches in bait-pails were large, coinciding with the peak of emergence of the overwintering brood. The catches in bait-pails did not increase again in number until the middle of August corresponding with the peak of emergence of the second brood. It is believed that the high percentage of moths in the krummel block, in May, was due to the concentration of the larvae in this block the preceding Fall. (It should be noted that there are only 990 krummel trees to more than 11,000 trees of early varieties as Carmen Hale, Hiley, Elberta, etc.) A scattering of the moths then took place, going to the blocks of earlier fruit. After the removal of the early peaches, the percentage of moths increased again in the Krummel block.

In the second place the percentage of parasitism was remarkably low. During the second summer brood on July 5th to 15th, five hundred and fifty larvae were gathered from wormy peaches. Only two parasites emerged from these larvae. No record is available for the percentage of parasitism during the third brood but it was apparently light.

Weak Acids as Baits. The results of the work conducted by the writer in 1925,[2] clearly demonstrated that the acids formed in fermenting molasses and sugar solutions contributed largely to the attractiveness of such baits. It was hoped, therefore, that the fermenting bait could be replaced by a mixture of acid and water. Acetic acid, the principal acid involved, was tried but yielded nothing of merit. It was then thought that certain weak acids, occurring only in very small amounts as a result of fermentation, might be attractive to the oriental fruit moth. Consequently one or more tests were made, at various strengths, using Succinic, Salycilicic, Butyric and Benzoic acids. These, by the way, also occur in certain volatile oils which gave the writer additional reason for trying them. None, however, gave satisfactory results. Lactic acid

[2]Jl. Econ. Ent., 19:441-450, 1925.

EXPLANATION OF PLATE 2

Dilutions are given per pail.

10 pails were used in tests marked thus (*) otherwise 5 pails were used.

Tenths of moths are given only in the column of total to the right of the chart.

Mo. = Molasses, (Ch.) = Higrade molasses, (Bl. S.) = Low grade or Black strap molasses, S.A. = Sodium arsenite, S. B. = Sodium borate, S. Ben. = Sodium benzoate.

Emergence of moths represented by curves.

was tried because moths were seen frequenting water troughs where milk cans had been washed. The accompanying table of acid-baits shows plainly that such baits, at least at the dilutions used, are of no value. Higher dilutions would be too expensive and impractical.

RESULTS OF CERTAIN WEAK ACIDS USED WITH WATER AS BAITS FOR ORIENTAL FRUIT-MOTH

Bait[1]	Dilution[2]	Number of pails	Duration of test		Average[3] catch per pail
			Period	No. days	
Acetic acid	12 c.c.	10	May & June	35 days	5.9
Acetic acid	10 c.c.	5	August	28 days	3.6
Acetic acid	5 c.c.	5	July	35 days	2.4
Acetic acid	5 c.c.	5	July & Aug.	35 days	1.4
Succinic acid	1 gr.	5	June & July	49 days	0.6
Salycilicic acid	2 c.c.	5	August	21 days	0.2
Butyric acid	1 c.c.	5	July & Aug.	49 days	0.4
Benzoic acid	2 c.c.	5	August	35 days	0.6
Citric acid	1 gr.	5	July	35 days	2.6
Citric acid	1 gr.	5	July & Aug.	42 days	0.6
Lactic acid	1 c.c.	5	July & Aug.	49 days	2.2
Lactic acid	2 c.c.	5	July & Aug.	35 days	0.0

[1]In all cases the acids were diluted with ½ gal. of water and placed in No. 10, painted, tin pails.

[2]Dilution is figured on the amount placed in single pail.

[3]The number of oriental fruit moths per pail.

VOLATILE OILS AS BAITS. Attention was then directed to certain volatile oils and some of their ingredients. Time permitted the trial of but a few of these. Two or three drops of linalool and geraniol were placed on the surface of water in two different series of pails but the catches approximated those from plain water. Such monatomic alcohols would not however be practical when used in this manner because they are too volatile and too expensive.

The property that the odors of certain volatile oils are readily absorbed by water, gave another suggestion for preparing an attractive bait. A deep, purple, strongly odoriferous volatile oil was extracted, by means of distillation, from peach leaves. The odorized waters, for convenience called "peach-leaf essence," was tried as baits on two occasions. Although no satisfactory results were obtained from these tests, the method still lends opportunity for further investigation with other volatile oils.

FERMENTING SUGAR BAITS. A series of tests was conducted to compare the relative values of fermenting sugar baits. Sugars were compared with molasses on the basis that granulated sugar is 99.8%,

brown sugar 82.% and molasses 40% cane sugar. The results, summarized in the accompanying charts, indicate that sugars and high grade molasses are more attractive than low grade molasses, and that certain non-fermenting baits were nearly as attractive as the fermenting baits. Karo likewise gave large catches of moths.

Some Miscellaneous Baits. A few miscellaneous materials were tried as baits and are summarized in the accompanying table. Karo suggested glucose but the results were disappointing. It is interesting to note that red engine oil increased the catch when placed on the surface of water. This was used in a few tests to reduce slopping and prevent excessive evaporation.

Results of Some Miscellaneous Bait-Tests Conducted During 1926

Bait	Dilution[1]	Number pails	Duration of test Period	No. days	Average catch per pail
Water		5	May to July	96 days	1.5
Water		5	July & Aug.	49 days	3.0
Water, red engine oil on top		5	Aug.	42 days	14.2
Ethel alcohol & water	4 c.c.	5	June	35 days	0.2
Glycerine & water	2 c.c.	5	July	35 days	0.4
Glucose & water	10 c.c.	5	July & Aug.	35 days	0.6
Flour & water	1½ oz.	5	Aug. & Sept.	49 days	10.8
Saccharine & water	½ gr.	5	June	35 days	0.4
"Peach leaf-essence"		5	Aug.	21 days	2.6
"Peach leaf-essence"		5	Sept. & Oct.	56 days	0.6

[1]The dilution is figured on the amount placed in each pail.

Non-Fermenting Baits. Various antiseptics or preventatives, chiefly sodium salts, were added to sugar and molasses baits to inhibit the development of yeasts, bacteria and molds, and th s to prolong the active period of the bait. This results in a sweet bait, of uniform character, operating without change over a long period of time. One bait of this type was still sweet and actively functioning at the end of 147 days.

Sodium arsenite is objectionable because it strongly favors the growth of mold, is expensive and causes serious burning to foliage and bark whenever it is spilled. On the other hand Sodium benzoate inhibits mold growth, also prevents fermentation, is inexpensive and otherwise as effective. During 1925 the catches from Sodium arsenite baits surpassed those from plain molasses baits, but during the present season the catches from molasses baits was slightly higher. From a practical standpoint, however, the non-fermenting baits may prove more satisfactory.

The following table summarizes various tests with different antiseptics to inhibit the growth of yeasts, bacteria and molds. Fermentation was determined by means of fermentation tubes and mold growth simply by an examination of the surface of the bait. Sodium benzoate at the rate of 2 ounces to ½ gal. of bait is a satisfactory antiseptic for this purpose.

A STUDY OF SOME ANTISEPTICS INHIBITING THE GROWTH OF YEASTS, BACTERIA AND MOLDS[1]

Antiseptic	Fermentation occurring at end of	No fermentation at end of	Amount of fermentation	Mold on top of bait
Sodium hypochlorite 14 grams*	26 days*		Strong	Abundant green
Sodium chloride 113.4 grams	2 days		Strong	?
Sodium chloride 113.4 grams	2 days		Strong	Abundant
Sodium carbonate 14 grams	1 day		Strong	Abundant
Sodium carbonate 50 grams*	4 days		Strong	Abundant
Sodium bicarbonate 14 grams	1 day		Strong	Abundant
Sodium bicarbonate 50 grams*	3 days		Strong	Abundant
Sodium borate 20 grams*	16 days		Moderat	Abundant
Sodium borate 20 grams	18 days		Strong	Abundant white
Sodium borate 50 grams*		50 days	Moderate	Abundant white
Sodium borate 113.4 grams		50 days	Moderate	None
Sodium arsenate 10 grams	4 days		Slight	Abundant green
Sodium arsenite 7 grams	20 days			Some
Sodium arsenite 7 grams*	13 days		Slight	Some
Sodium arsenite 14 grams*	28 days		Slight	Abundant
Sodium arsenite 14 grams		50 days		Abundant
Sodium arsenite 20 grams*		120 days[2]		Abundant black
Sodium benzoate .25 grams*	2 days			Some
Sodium benzoate .5 grams*	2 days			Some
Sodium benzoate 1 gram*	5 days		Trace	None
Sodium benzoate 1 gram*	6 days		Trace	None
Sodium benzoate 8 grams*		60 days		None
Sodium benzoate 1 gram*	29 days		Trace	None
Sodium benzoate 2 grams*		60 days		None

[1]All the baits consisted of 200 c.c. high grade molasses to 2000 c.c. water. Samples marked thus (*) were placed in an incubator at 30°C. The others were run at room temperatures from June to September.

[2]Dr. D. E. Haley, Agricultural Chemist, Penna. State College, carried on some experiments and found that .25 gram of sodium arsenite did not interfere with the fermentation process, .5 and .75 grams delayed it while 1 gram completely inhibited the reaction, when added to 10 grams of high grade molasses.

Orchard Tests of the Bait-Pail Method of Control

A block of 990 krummel peach trees was selected for different tests. Plot No. 1, containing 451 trees, was used from May 1st to November 1st to compare various types of baits.

Plot No. 2, consisting of 55 trees was left as a barrier between plots Nos. 1 and 3.

In plot No. 3 bait pails were hung on June 8th on each of 44 trees, filling them one-half full with a mixture of 1 part high grade molasses and ten parts water. Water was added to these pails on June 29th, July 20th and August 3rd. On August 10th new bait composed of granulated sugar and water was added.

Plot No. 4, consisting of 44 trees, was left unpailed, as a check.

Plot No. 5, containing 44 trees was equipped with pails on August 1st, placing a pail on each tree and filling them with a mixture of 1 part high grade molasses and ten parts water. Water was added on August 27th. On September 10th they were replenished by new bait consisting of granulated sugar and water.

Plot No. 6, comprising 352 trees was left unpailed, with the exception of a few pails (about 40) placed there by the orchardist. These were of little account from the control standpoint.

The diagram of the orchard shows the relative position of the pailed and unpailed trees. Only a corner of the orchard is shown. To the south of this portion there are over 8,000 trees of the varieties; Carmen, Elberta, Smock and Fox seedling.

Results. An attempt was made to gather and examine 100 picked peaches from the plots every two weeks. The accompanying figure are not very complete but clearly show the steady increase of infestation with the progress of the season.

Examination of Krummel Peaches from Pailed and Unpailed Plots During the Summer[1]

Date of examination	Percentage of wormy fruit in		
	Plot 3 Pailed June 8	Plot 4 Unpailed	Plot 5 Pailed August 1
June 24	0	—	—
June 30	0	—	—
July 13	1	—	—
August 3	1	1	—
August 17	7	5	4
August 31	6	5	—
September 14	2	7	6.5
September 14[2]	4	10	5

[1]All examinations except the last were based on 100 picked fruit.

[2]Based on 1000 fruit in each plot, gathered in thinning.

Tallies of picked fruit were made on October 12th and 13th. At this time practically all the fruit had been removed from the orchard, except fruit on trees tagged for counts. The fruit was picked somewhat earlier than usual. The percentage of wormy fruit was not high and the percentage of infestation only slightly higher than the percentage of wormy fruit in the unpailed plots.

SUMMARY OF ORIENTAL FRUIT MOTH COUNTS IN RICE, KRUMMEL PEACH BLOCK, ADAMS CO., PA., 1926

Plot	No. fruit examined	No. wormy fruit	No. of worms	Percentage wormy fruit	Percentage infestation
3, Pailed June 8.....	1424	257	257	18.0	18.0
4, Unpailed.....	1970	429	444	21.7	22.5
5, Pailed Aug. 1.....	1512	298	306	19.6	19.9
6, Unpailed.....	1437	646	757	44.9	52.6

On the basis of the preceding studies as well as the investigations of the previous season, the writer believes that bait-pails still deserve merit as a control measure for the Oriental fruit moth. Large numbers of certain insects as, *Euphoria fulgida*, two species of *Cotinis*, *Carpocapsa pomonella*, and other injurious insects have been captured in bait-pails and this method may prove of value in controlling other pests.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by Alvah Peterson.

SOME BAITS MORE ATTRACTIVE TO THE ORIENTAL PEACH MOTH THAN BLACK-STRAP MOLASSES

By ALVAH PETERSON, *Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A number of the bait experiments of previous seasons for *Laspeyresia molesta* were repeated and in most cases the results obtained were duplicated. Enameled stewpans and wide mouth, glass, quart jars proved to be the most satisfactory containers.

Some 250 aromatic chemicals were tested. Terpineol and several essential oils (fennel, Bergamot, star anise, anise seed and *Pinus sylvestris*) were somewhat attractive to moths. If one compares the attractiveness of any one of these products with that of several fermenting sugar-possessing products it is much less.

Fermenting fruits (dried fruit in water), particularly prunes, pears and apricots, attract a goodly number of moths.

Baits made of cheap black-strap molasses (5 to 20 per cent dilutions) are fairly attractive but they usually produce considerable scum and their period of attractiveness is not very long.

Honey, corn syrups, refiner's syrups and brown sugar (5 or 10 per cent solutions) are much more attractive than black-strap molasses. These products and others of

a similar nature produce little or no scum when fermentation occurs and their period of attractiveness is of considerable length (several weeks).

Fermentation or some change occurs in all baits made of sugar-possessing commercial products before they become very attractive to the oriental peach moth. Several of the common disinfectants delay but do not permanently prohibit fermentation when added to the sugar-possessing products used in the experiments.

Further investigational work on baits attractive to the oriental peach moth, *Laspeyresia molesta* Busck, was conducted by the author in orchards about Riverton, New Jersey during the growing season of 1926. A number of interesting facts were learned and a few of the more important ones will be discussed.

METHODS. In all of the tests, unless stated otherwise, two quart enameled stewpans were used (for description see reference 2). During mid-season over one thousand bait containers were located in nearby orchards and examined daily or three times per week. The location of the containers in the orchards in all of the experiments was made as nearly the same as possible, e. g. they were placed at the same height, usually on the same side of the trees, among trees of the same variety and equally distributed, as a rule one in every other tree in every other row. Each product was tested in units of five or ten containers. In a few tests forty or more containers were employed for each product.

The tables show the total catch of moths for the period covered by each test. Some of the more important experiments are included in the tables. Space will not permit a presentation of the number of moths caught in individual pans or the totals for each collection. This eliminates the possibility of demonstrating the influence of weather conditions on the catch. It will also be necessary to omit information which would illustrate the period of time that each bait is most attractive.

For two seasons at Riverton, New Jersey the most favorable time to make observations on the attractiveness of baits has been during the period when the first brood adults are present in the orchard, usually late in June or early in July.

GENERAL. Some of the experiments conducted during previous seasons were repeated in order to obtain further proof on former observations. It was noted again that bait containers kept well filled with baits (Table 1) catch many more adults than when partly filled. The most satisfactory container from the standpoint of the number of moths caught again proved to be an enameled stewpan, two quarts capacity (Tables 1 and 2). The next best container was a wide-mouth, quart, glass jar. In some of the tests where the jars were placed high in the

trees they caught nearly as many adults as the stewpans. Further tests this year showed that containers (jars used) located high in the trees catch more moths than when placed low (Table 1).

Tin and aluminum containers are not very durable when filled with fermenting baits. There appears to be a chemical reaction between the bait and the metal. This is particularly true with aluminum ware. Tin or rusty containers have some influence on the attractiveness of a fermenting bait. In several tests a marked reduction in the catch occurred when the bait was suspended in rusty or tin containers.

Aromatic Chemicals. A considerable number (about 250) of aromatic chemicals were tested during May and June in several apple and peach orchards to determine their attractiveness to oriental peach moths. These products were largely essential oils, alcohols, esters, aldehydes, acids and sugars. The various chemicals were placed in small evaporating cups (for description see reference 3) and floated on water in two quart enameled stewpans. The following products were sufficiently attractive to bring moths to the pans so that one or more specimens were taken in each of five or more collections; terpineol, fennel oil, Bergamot oil, star anise oil, anise seed oil and *Pinus sylvestris* oil. Moths were taken at three different collections from pans possessing isosafrol and terpinyl acetate. The following products, had one or two moths in one or two collections; essential oils such as citronella, petit grain, thyme (white and red), peach kernels, neroli, capsicum, hemlock, savin, turpentine, rose geranium, lemon, clove, sage, cymene, eucalyptus pennyroyal and lavender fleurs; also anthranilic, acetic and uric acids, benzyl, hexyl and iso-propyl alcohols, glycerine, aldehyde, cresol, m-cresol, cinnamaldehyde, salicyaldehyde, beta-bromostyrene, pyridine, furfural, benzyaldehyde, toluol, menthol, betaine hydrochloride, hyoscyamine, leucine, gum arabic, frangula bark, iso-butyl n-butyrate, amyl salicylate, limonene, iso-amyl valerianate, iso-butyl phenylacetate etc. The author is of the opinion that many of the products just named are not attractive. The presence of moths in pans possessing the chemicals was probably accidental in many cases. No one aromatic chemical or commercial product proved to be anywhere near as attractive as many of the fermenting molasses, syrup, sugar and fruit baits.

Dried Fruit. Several dried fruits, peaches, pears, prunes, apricots and apples, were used to attract moths. In most of the tests similar amounts of each fruit (usually 30 to 35 grams) were placed in enameled stewpans filled with clean water. No adults came to the pans until the fruit started to ferment. During the summer it usually took three to

seven days for fermentation to get a good start. As soon as bubbles, due to fermentation, appeared, moths came to the pans. The maximum catch of moths usually occurred seven to fourteen days after the fruit was placed in the orchard. The few tests made with dried fruit (Table 6a) show that prunes and pears are probably the most attractive, apricots and peaches come next and apples last. Dried fruit when placed in water absorbs moisture and as soon as fermentation starts the fruit usually becomes lighter than water and floats on the surface. Floating fruit undoubtedly interferes with the maximum catch. It is probable that submerged, fermenting, fruit will catch more adults.

If one compares the attractiveness of fermenting dried fruit baits with that of baits made up of fermenting molasses, syrup or sugars the former is usually less attractive. Some of the individual collections from fruit baits ran higher than molasses, syrup and sugar baits but their period of attractiveness was much shorter, consequently the total catch was smaller.

Mr. E. H. Siegler and Mr. L. Brown conducted some bait experiments with dried fruits, sugars and syrups in Maryland peach orchards this past season. They kindly furnished me a copy of their field notes. Their experiments indicate that apricots were the most attractive of the dried fruits. The results they obtained with other products agree closely with those reported upon in this paper.

Syrups etc. In the June issue of this Journal for 1926 the author (reference 2) reported that a five or ten per cent solution of stock molasses, (black-strap molasses) was attractive to oriental peach moths. Two seasons experience with this product show that there are several difficulties to be overcome if black-strap molasses is to be used as a control measure. The chief objection is the fact that ten and twenty per cent solutions ferment rapidly and form an excessive amount of foam which results in a thick or thin scum over the surface of the liquid. This interferes with the capture of adults which come to the containers. The scum has to be removed two or three times after fermentation starts if a number of adults are to be caught. Five per cent solutions do not produce a great amount of scum as a rule but in hot weather this strength produces more than desired. If bait pans are only examined every week or two, scum formation would materially reduce the number of moths captured. Another objection to the use of black-strap molasses for baits is the fact that its period of maximum attractiveness to moths is relatively short.

During the past season baits made of cheap black-strap molasses have been compared with baits made of several common, sweet, com-

mercial products (syrups and sugars) particularly those possessing a sugar content higher than black-strap molasses. The tables (4, 5 and 6) show that there are several products which are superior to black-strap molasses in that they attract more moths, they produce little or no scum and their period of maximum efficiency is much longer. These products are honey, dark and light colored corn syrups, refiner's syrups and brown sugars. Coarse corn sugar, some grades of table molasses and hydrol proved to be as attractive as black-strap molasses in some of the tests.

Honey is probably the most attractive product found to date (Tables 4 and 5). The chief objection to honey is the fact that honey bees may consume all of the bait if there is a shortage of food in the vicinity where the baits are located. The cost of honey also prohibits its use.

Corn syrup (Tables 2, 4, 5 and 6), particularly one of the common dark colored grades on the market, has proven to be very attractive. As a rule it takes longer for a ten per cent (or greater strength) solution of corn syrup to become attractive than most other baits of a similar nature but once the attractive stage is reached the period of attractiveness is usually much longer than that of any other bait. Corn syrup baits seldom if ever form a scum on their surface. They are considerably more expensive than black-strap molasses but cheaper than honey.

Several grades of refiner's syrups (Tables 2, 4 and 6) proved to be very attractive, particularly five and ten per cent solutions. In most tests the five per cent solution was the best. Baits made of refiner's syrups become attractive a few hours, twenty-four to forty-eight, after they are placed in the orchard. Refiner's syrups cost 25 to 40 cents per gallon in fifty gallon lots. This is two or three times the cost of black-strap molasses.

Brown sugars (Tables 4, 5 and 6) in some of the tests proved to be decidedly attractive to moths, particularly ten and twenty per cent solutions. There was some variation in the results obtained however, with the several grades tried which could not be accounted for. Coarse and fine corn sugars (Tables 4 and 5) also caught large numbers of adults in some of the tests. Coarse corn sugar is cheap and may prove to be quite satisfactory. The sugar baits formed no scum on the surface of the liquid. One or two grades of table molasses and hydrol also proved to be fairly satisfactory and more attractive than black-strap molasses in some instances.

Space will not permit a presentation of the chemical analyses of the several commercial products employed. Comparing the chemical make-up of the several products with the respective attractiveness of

each it appears that those products which have a sugar content greater than 62 per cent caught many more adults than similar products, such as black-strap molasses, where the sugar content was 48 to 54 per cent. Further tests are needed to corroborate this conclusion.

FERMENTATION. The results obtained this season convince the author more firmly than ever before that any sweet product (molasses, syrup or sugar) must start to ferment or undergo some sort of a change before it becomes very attractive to oriental peach moths. Honey appears to be the only product which will attract a goodly number of moths the first days it is placed in the orchard. Even baits made of honey become more attractive when they have been outdoors a few days and show distinct signs of fermentation or some change.

Yeast is unnecessary to start fermentation. Early in the spring when the nights are cold the addition of yeast will hasten fermentation. A natural infection of fermenting organisms always occurs under orchard conditions; however, in cool weather, it always takes longer to start than in hot weather.

In a number of tests some of the more common disinfectants were used to prevent fermentation (Table 3). As long as no fermentation took place few or no moths came to the baits. To our surprise most of the common disinfectants employed were effective for a few days only. All delayed fermentation, but sodium benzoate, 1–100, was the only product which usually prevented fermentation and when this was used very few moths were found in the containers during the entire period of each test. Several strengths of the disinfectants were tried. The following were the maximum strengths tested; bichloride of mercury, 1–1000, sodium arsenite 1–500, potassium permanganate, 1–200, copper sulfate, 1-500, chlorinated lime, 1–1000, and sodium benzoate, 1–100. In another series of tests the fermenting baits were taken into the laboratory and boiled for one hour and then returned to the orchard. Boiled baits for a few days after they were replaced in the orchard always caught a smaller number of moths than baits which had not been boiled. The total catch of moths taken from molasses and syrup baits where disinfectants were added was usually much smaller than from containers which held untreated baits.

CONTROL. A conclusion on liquid baits as a possible means of control will not be made at this time. Present indications point to the fact that a liquid bait may prove to be impractical and ineffective. The author advises growers to refrain from using baits as a means of control until more definite information can be given.

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3.—1926. ALVAH PETERSON. An evaporation cup useful for chemotropic studies of insects in the field. Jour. Econ. Ent., vol. 19, pages 863–866.

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TABLE 1. BAIT CONTAINERS, THEIR LOCATION, ETC.

Results of several miscellaneous bait experiments extending from May 1 to September 8, 1926 in Taylor's peach orchard near Riverton, New Jersey. All of the containers were filled with the following baits, table molasses, 1–15 plus yeast from May 1 to May 17, black-strap molasses, 1–10 plus yeast from May 19 to June 30, and dark corn syrup from June 31 to September 8. In experiments 1a to 4a the four types of containers were located at the same height in each (same) tree. In experiments 5b to 7b the three jars at different heights were located in each (same) tree. In experiments 8c and 9c the two tin pails, one filled and the other one-third filled were located in each (same) tree. In experiments 10d and 11d one pan and one jar were located in each (same) tree at heights indicated.

Number and series	Container	Feet above ground	Number of containers	Number of trees	Number of moths	Series %
1a	Two quart enameled stewpan	5	5	5	1318	60.4
2a	One quart wide-mouth glass jar	5	5	5	296	13.1
3a	Three quart tin pail	5	5	5	317	14.0
4a	One quart tin pail	5	5	5	248	11.3
5b	One quart wide-mouth glass jar	2–3	5	5	117	14.4
6b	One quart wide-mouth glass jar	5–6	5	5	262	32.2
7b	One quart wide-mouth glass jar	7–9	5	5	433	53.3
8c	Three quart tin pail, filled	5	10	10	421	83.3
9c	Three quart tin pail, one-third filled	5	10	10	84	16.6
10d	Two quart enameled stewpan	5	10	10	1500	63.6
11d	One quart wide-mouth glass jar	7–9	10	10	856	36.3

Note. A given series of tests is designated by a common alphabetical letter.

TABLE 2. BAIT CONTAINERS AND THEIR LOCATION

Moths caught in bait experiments conducted at Wetherby's peach orchard near Swedesboro, New Jersey. There were five containers in each test and they were examined once a week. In all of the experiments the stewpans were placed 5–6 feet above ground, the tin pails 7–8 feet above ground and the quart jars 9–12 feet above ground. In experiments 2a, 4b, and 7c there were three containers in each tree, one of each type but in all other tests only one container was placed in each tree.

Number and series	Material	Containers per tree	Period of test	Two quart stewpans	Three quart tin pails	One quart wide-mouth glass jars
1a	Black-strap molasses, 10%	1	May 30 to June 21	217	162	150
2a	Black-strap molasses, 10%	3	May 30 to June 21	92	79	72
3b	Black-strap molasses, 10%	1	June 21 to July 26	51	14	56
4b	Dark corn syrup, 10%	3	June 21 to July 26	234	48	97
5b	Dark corn syrup, 10%	1	June 21 to July 26	203	30	80
6c	Black-strap molasses, 10%	1	July 26 to Sept. 20	53	27	45
7c	Refiner's syrup, 5%	3	July 26 to Sept. 20	488	68	289
8c	Refiner's syrup, 5%	1	July 26 to Sept. 20	465	111	497
	Totals			1803	539	1286
	Percentage of grand total			49.7	14.8	35.4

Note. A given series of tests is designated by a common alphabetical letter.

TABLE 3. MOTHS CAUGHT IN BAITS CONTAINING SOME OF THE COMMON DISINFECTANTS

These tests were conducted in peach orchards near Riverton, New Jersey. There were five containers in each test. Experiments 1 and 2 started August 14 and ended October 1, experiment 3 started August 3 and ended September 4 and experiment 4 started August 31 and ended October 1.

Number	Material 10%	Check	Sodium benzoate, 1–100	Potassium permanganate, 1–200	Mercuric chloride, 1–1000	Sodium arsenite, 1–500	Chlorinated lime, 1–1000	Copper sulfate, 1–500
1	Table molasses	236	0	102	53	113	—	—
2	Refiner's syrup	165	5	145	200	43	—	—
3	Refiner's syrup	324	6	289	171	—	—	—
4	Table molasses	59	41*	24	41	70	124	35

*Sodium benzoate, 1–300.

TABLE 4. MOTHS CAUGHT IN SOME OF THE BAIT EXPERIMENTS CONDUCTED IN TAYLOR'S PEACH ORCHARD. TEN CONTAINERS USED IN EACH TEST. FIVE AND TEN PERCENT SOLUTIONS.

Number	Material	Period of test	Moths caught 5%	Moths caught 10%
1a	Black-strap molasses	July 2 to August 16	105	115
2a	Table molasses	July 2 to August 16	676	352
3a	Corn syrup, dark	July 2 to August 16	783	1386
4a	Refiner's syrup, medium	July 2 to August 16	1255	1028
5a	Sugar syrup, syrline	July 2 to August 16	135	369
6a	Honey	July 2 to August 16	1592	1822
7a	Cane sugar	July 2 to August 16	299	182
8b	Refiner's syrup, 208	July 17 to August 13	25	391
9b	Refiner's syrup, 226	July 17 to August 13	106	166
10b	Corn syrup, dark	July 17 to August 13	24	192
11b	Corn syrup, unmixed	July 17 to August 13	50	41
12b	Hydrol	July 17 to August 13	189	204
13b	Honey*	July 17 to August 13	31	38
14c	Honey	July 8 to August 9	482	——
15c	Refiner's syrup, medium	July 8 to August 9	306	——
16c	Table molasses	July 8 to August 9	276	——
17c	Brown sugar, N. O.	July 8 to August 9	224	——
18c	Corn syrup, dark	July 8 to August 9	174	——
19c	Corn sugar, fine	July 8 to August 9	171	——
20c	Corn syrup, light	July 8 to August 9	118	——
21c	Dextrine, white	July 8 toAugust 9	99	——
22c	Corn sugar, coarse	July 8 to August 9	93	——
23c	Black-strap molasses	July 8 to August 9	88	——
24c	Dextrine, yellow	July 8 to August 9	30	——
25c	Corn starch	July 8 to August 9	15	——
26c	Soluble starch	July 8 to August 9	0	——
27c	Water, check	July 8 to August 9	3	——
28d	Black-strap molasses	June 24 to August 20	444	——
29d	Corn syrup, dark	June 24 to August 20	978	——

*Honey bees consumed bait.

Note. A given series of tests is designated by a common alphabetical letter.

TABLE 5. MOTHS CAUGHT IN SOME OF THE BAIT EXPERIMENTS CONDUCTED AT LIPPINCOTT'S PEACH ORCHARD, RIVERTON, N. J.

Number and series	Material	Period of test	Number of pans	Total moths in ten pans (average)
1a	Black-strap molasses, 10%	June 29 to July 12	69	55
2a	Corn syrup, dark, 10%	June 29 to July 12	41	585
3b	Black-strap molasses, 10%	June 22 to August 2	10	195
4b	Black-strap molasses, 10% plus saponin, 1–5000	June 22 to August 2	12	151
5b	Black-strap molasses, 5%	June 22 to August 2	10	263

6b	Black-strap molasses, 10% plus sodium arsenite, 5 gm. per pan	June 22 to August 2	8	206
7b	Table molasses, 5%	June 22 to August 2	9	454
8b	Corn syrup, dark, 5%	June 22 to August 2	9	1423
9b	Corn syrup, light, 5%	June 22 to August 2	11	1169
10b	Honey, 5%	June 22 to August 2	10	861
11c	Brown sugar, N. O. 10%	August 3 to September 4	9	263
12c	Brown sugar, soft cane, 10%	August 3 to September 4	9	248
13c	Brown sugar, F, 10%	August 3 to September 4	10	174
14c	Corn sugar, fine, 10%	August 3 to September 4	10	171
15c	Corn sugar, coarse, 10%	August 3 to September 4	11	386
16c	Hydrol	August 3 to September 4	10	340
17c	Corn syrup, unmixed, 10%	August 3 to September 4	11	194
18c	Corn syrup, dark, 10%	August 3 to September 4	12	159
19c	Corn syrup, light, 10%	August 3 to September 4	11	190
20a–c	Water, check	June 22 to September 4	10	5

Note. A given series of tests is designated by a common alphabetical letter.

TABLE 6. MOTHS CAUGHT IN BAIT EXPERIMENTS CONDUCTED AT RICHIE'S PEACH ORCHARD NEAR RIVERTON, NEW JERSEY. FIVE CONTAINERS USED IN EACH TEST. TWO AND FIVE TENTHS, FIVE AND TEN PER CENT SOLUTIONS.

Number and series	Material	Period of test	Moths caught 2.5%	5%	10%
1a	Black strap molasses	June 26 to July 22	317	212	143
2a	Corn syrup, dark	June 26 to July 22	168	434	840
3a	Refiner's syrup, medium	June 26 to July 22	122	1290	785
4b	Black-strap molasses	July 31 to September 1	47	80	117
5b	Corn syrup, dark	July 31 to September 1	42	29	157
6b	Refiner's syrup, 208	July 31 to September 1	52	84	134
7b	Refiner's syrup, 226	July 31 to September 1	69	218	178
8b	Brown sugar, F.	July 31 to September 1	30	81	267
9c	Cane sugar	July 3 to July 22	—	101	—
10c	Brown sugar, F.	July 3 to July 22	—	818	—
11c	Corn syrup, dark	July 3 to July 22	—	197	—

TABLE 6a. MOTHS CAUGHT IN SOME OF THE DRIED FRUIT BAIT EXPERIMENTS (RICHIE'S ORCHARD) NEAR RIVERTON, NEW JERSEY. FIVE CONTAINERS USED IN EACH TEST.

Number and series	Fruit, per pan	Period of test	Moths
12a	Prunes, four	June 26 to July 22	422
13a	Apricots, six halves	June 26 to July 22	155
14a	Peaches, three halves	June 26 to July 22	121
15a	Pears, two halves	June 26 to July 22	474
16d	Prunes, 30–35 grams	July 31 to September 1	17
17d	Apricots, 30–35 grams	July 31 to September 1	53
18d	Peaches, 30–35 grams	July 31 to September 1	158
19d	Pears, 30–35 grams	July 31 to September 1	68
20a, d	Water, check	June 30 to September 1	2

Note: A given series of tests is designated by a common alphabetical letter.

MR. N. E. MCINDOO: I would like to ask Mr. Peterson if he is keeping a record of the number of male and female moths and a record of other insects.

MR. ALVAH PETERSON: Yes, we are keeping records of male and female moths. In certain catches we determine the number of insects and the condition of the females. So far the average will run about fifty per cent females and fifty per cent males and most of the females caught have not deposited their eggs.

To a limited extent we are taking care of other insects. We get so many other insects that we can't handle all of them. We have some very interesting facts along that line. Two or three important species of wireworms came to the pans in large numbers, and one or two other species. Of course we kept track of the codling moths that came to these pans.

MR. G. A. DEAN: It may be of interest to know that in our efforts to find some attrahent that might be effective in a bait for wireworms, we found common honey is the outstanding attrahent for the beetles, and with us the price of honey is not prohibitive, due to the fact that we can get a cheap alfalfa honey from California for seven cents, and it has a very strong odor. I would like to know if they have found that honeys with strong odors are more attractive than the mild honeys.

I will also say that in all our grasshopper and cutworm and army worm baits, the baits are far more attractive when the juices have been fermented, or even the black-strap molasses, where the juices have had an opportunity to ferment over night.

MR. PHILLIP GARMAN: What price have you been paying?

MR. ALVAH PETERSON: It runs between twenty-two and thirty cents a gallon for refiners' syrup in fifty-gallon lots.

SECRETARY C. W. COLLINS: I would like to ask if you have tried preserving the females in gasoline, xylol, benzol or something of the kind, or the tips containing the reproductive organs to attract the males.

MR. ALVAH PETERSON: No, we have not.

SECRETARY C. W. COLLINS: We conducted some experiments with the gipsy moth along those lines and have had encouraging results and also some that were not so encouraging, because it is so variable. With some experiments of that kind this year in New Jersey we had some cages with tips preserved in xylol and we attracted some males in a few places where scouting had been done pretty thoroughly, and probably in that area we would not have been able to have repeated this work within a year or so, and this gave us a clue to go back to this area. A very bad

infestation has just turned up in that area as a result of these attraction experiments, using the tips in xylol.

FIRST VICE-PRESIDENT C. J. DRAKE: The next paper is by L. A. Stearns.

THE HIBERNATION QUARTERS OF *LASPEYRESIA MOLESTA* BUSCK[1]

By LOUIS A. STEARNS, *Assistant Entomologist, Agricultural Experiment Station, New Brunswick, New Jersey.*

ABSTRACT

In 1924, experimental orchard cultivation, supported later by laboratory tests, showed conclusively that thorough cultivation, during the latter part of the month of April, consisting of a plowing to the depth of six inches followed by a disking to the depth of four inches was 100 per cent efficient in the destruction of the larvae and pupae of the Oriental Peach Moth (*Laspeyresia molesta* Busck) which had passed the winter upon the ground.

The results of further work, in 1925, to determine the relative effectiveness of disking only as compared with plowing only and as compared with these two operations combined, demonstrated the equally high efficiency of a thorough cultivation consisting of disking alone.

In 1926 a final study was conducted to determine the relative numbers wintering *upon* the tree and *away* from the tree in order to establish the actual extent of the effectiveness of cultivation in the control of this insect. The results of this study indicate the following distribution of the overwintering population under present average conditions in New Jersey—14 per cent in the upper portions of the tree, 11 per cent on the tree trunk and 75 per cent away from the tree—percentages correlated with the abundance of mummies and applicable elsewhere subject to variances in infestation and orchard practice. It was also determined that of those larvae overwintering upon the tree trunk 88 per cent constructed hibernacula within the area included in the mound formed when applying paradichlorobenzene for the control of the peach-tree borer, an insecticide also toxic in the case of this insect.

These studies, although disclosing the fact that cultivation and the paradichlorobenzene treatment should destroy a high percentage (86%) of the hibernating Oriental Peach Moth, indicate an overwintering population in the upper portions of the tree sufficiently large to constitute a continuance of infestation from year to year in spite of the thorough application of these measures.

The knowledge of the relatively unprotected character and location of these remaining hibernacula suggests the advisibility of further work with insecticides of a penetrating nature, with the attendant possibility of placing the control of the insect largely if not wholly within the dormant period.

Throughout the entire course of the investigation of the Oriental Peach Moth in New Jersey, up to the present time, cultivation in the spring of the year as an effective method for reducing the overwintered numbers of this insect has received considerable attention. The results

[1]Paper No. 333 of the JOURNAL Series, New Jersey Agricultural Experiment Stations, Department of Entomology.

of these control studies have been detailed in recent reports of the Department of Entomology of the New Jersey Stations, and elsewhere[2].

In 1924, experimental orchard cultivation supported later by laboratory tests, showed conclusively that thorough cultivation, during the latter part of the month of April, consisting of a plowing to the depth of six inches followed by a disking to the depth of four inches was 100 per cent efficient in the destruction of the larvae and pupae of this insect which had passed the winter upon the ground. The disinclination or inability on the part of many peach growers to use the plow necessitated further study in 1925, to determine the relative effectiveness of disking only as compared with plowing only and as compared with these two operations combined. The results of this work demonstrated the equally high efficiency of a thorough cultivation consisting of disking alone. Spring cultivation has been recommended, therefore, not only as an effective but also as a relatively economical control measure, since it did not interfere with established orchard practice aside from advancing the date of the turning-under of the cover crop.

These studies had been based, unfortunately, upon a supposition, that since the hibernacula can seldom be located in the upper portions of the tree and but occasionally in the crotches of the larger limbs and in crevices and rolls of bark and about the margins of exuded gum on the trunk, especially near soil level, the greater majority of the larvae must secrete themselves for passing the winter in and under trash (leaves, grass and weeds) and in and on mummies upon the ground beneath the spread of the tree. It was not until the present year (1926) that conditions were such that a careful study could be made to determine the relative numbers of larvae wintering *upon* the tree and *away* from the tree and to establish, thus, the actual extent of the effectiveness of cultivation in the control of this insect.

Details and Discussion. In this study which was conducted at the College Fruit Farm, at New Brunswick, nine peach trees, varying in age from 6 to 10 years and representing six mid and late season varieties, were employed. The selection was such as to include high, low and averaged-headed types as well as trees presenting extremes in the amount of trash and the number of mummies upon the ground. Each of the trees was enclosed in a 10′x10′x10′ framework covered with a 32x28 mesh cotton gauze. (*Pl. 3, fig. 1*). These cages were so partitioned as to provide for the recording of separate emergence data for the three hibernating areas—the upper portions of the tree, the tree trunk and the surface of the ground beneath the spread of the tree. (*Pl. 3, fig. 2*). The records of emergence with additional data showing the correlation

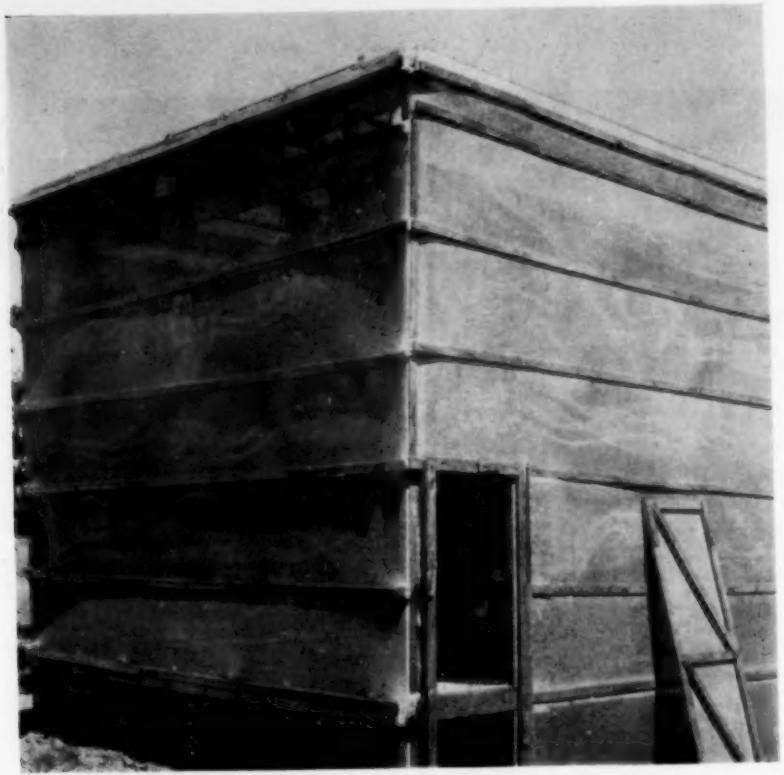
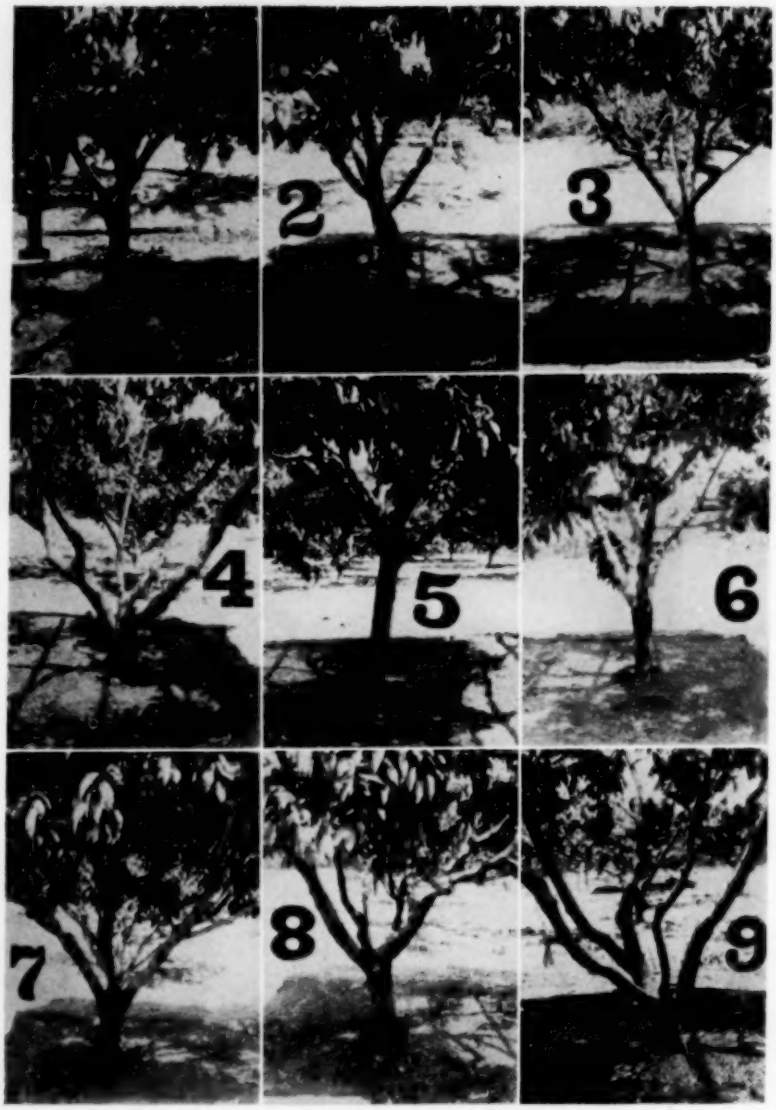


FIG. 1. Exterior and general construction of one of the nine cages employed in study of the hibernation quarters of the Oriental Peach Moth, New Brunswick, New Jersey, 1926.

FIG. 2. View through door of one of the nine cages employed in study of the hibernation quarters of the oriental Peach Moth, showing partitioning to segregate emergence records for the upper portions of the tree, the tree trunk and the ground beneath the spread of the tree, New Brunswick, New Jersey, 1926.



Nine peach trees employed in study of the hibernation quarters of the Oriental Peach Moth showing details of heading and branching, New Brunswick, New Jersey, 1926.

between the number of mummies and the per cent hibernating away from the tree are presented in Table 1.

TABLE 1. RECORDS OF EMERGENCE OF SPRING BROOD ADULTS OF THE ORIENTAL PEACH MOTH IN CAGES ENCLOSING NINE 6- TO 10-YEAR OLD PEACH TREES, NEW BRUNSWICK, NEW JERSEY, 1926

Tree	Varieties	Emergence: Number from upper portions of tree	Emergence: Number from tree trunk	Surface of ground beneath spread of tree: Number	Surface of ground beneath spread of tree: Number of mummies	Per cent of total emergence in cage
1	Elberta	2	0	0	31	0.0
2	Osprey Improved	4	5	0	38	0.0
3	Krummel's October	6	3	1	68	10.0
4	Late Champion	4	10	1	72	*6.7
5	Krummel's October	10	6	4	78	20.0
6	Krummel's October	3	1	2	96	33.3
7	Heath Cling	2	0	6	107	75.0
8	Heath Cling	1	0	4	122	80.0
9	Lippiatt's Late Red	7	1	6	131	*42.9
	Totals	39	26			
	Averages	4.3	2.9			

*See discussion.

The data in *Table 1* indicate an average total overwintering population of four individuals in the upper portions of the tree and three on the tree trunk, records, which it is believed, represent with approximate accuracy the situation in this orchard under existing conditions of infestation. The additional data included in this table suggests a definite correlation between the number and percentage hibernating away from the tree and the presence or absence of mummies. With the exception of trees 4 and 9, which were the lowest-headed of the group and which present a branching type affording unusually favorable cocooning quarters on the tree (*See Plate 4*), the percentage hibernating away from the tree was directly proportionate with the number of mummies present on the ground. It will be noted further that this percentage increases rapidly with rather insignificant increases in the number of mummies. Inasmuch as the trees were deliberately selected to include a gradation in the number of mummies, the record of three which might be figured from the data in the table to represent the average total population overwintering away from the tree, would express inadequately actual conditions. Records show that under present average

[2]Ann. Repts. Dept. Ent. N.J. Agr. Exp. Stas. for the years ending June 30th, 1925, and June 30th, 1926; Proc. Ann. Meeting N. J. State Hort. Soc. November, 1924, and December, 1925; Jour. Econ. Ent. Vol. 18, No. 1, Feb. 1925, pp. 191–199.

conditions in New Jersey in excess of one hundred mummies per tree is a normal occurrence. The results of this study would seem to indicate, therefore, the following distribution of the overwintering population—14 per cent in the upper portions of the tree, 11 per cent on the tree trunk and 75 per cent away from the tree, percentages applicable elsewhere subject to variances in infestation and orchard practice.

With the number of individuals hibernating and emerging from the upper portions of the tree and the tree trunk known, a careful search was made to ascertain the exact location of the hibernacula. The resulting data has been summarized in *Table 2*.

As will be seen by reference to *Table 2*, it was possible to locate all hibernacula on the tree trunk. In the case of those in the upper portions of the tree on the other hand, and notwithstanding the fact that the search was greatly facilitated by the presence of the empty pupal cases protruding from the cocoons, only one-third of the total number emerged could be located. Observations made on the character of these hibernacula show that in the vicinity of 40 per cent were located on but slightly roughened surface bark in such exposed positions as to be wholly unprotected from a drenching dormant spray.

TABLE 2. RECORDS OF LOCATIONS OF HIBERNACULA OF THE ORIENTAL PEACH MOTH ON 6- TO 10-YEAR OLD PEACH TREES, NEW BRUNSWICK, NEW JERSEY, 1926

Vertical distance from ground (soil level)	Upper portions of tree	Tree trunk	
	Number	Number	Per cent
0″		6	23.0
1″		1	27.0
1½″		8	58.0
2″		1	61.5
2½″		2	69.0
3½″		1	73.0
4″		2	80.0
6″		2	88.0
1′0″		2	96.0
1′10″		1	100.0
2′3½″	1		
2′4½″	1		
2′7″	1		
2′8″	1		
3′3″	1		
3′8″	2		
4′0″	4		
4′6″	2		
Totals	13	26	
Percentages of total moths emerged	33.3	100.0	

It is especially significant from the control standpoint that of those larvae overwintering upon the tree trunk 88 per cent had constructed hibernacula within the area included in the mound formed when applying paradichlorobenzene for the control of the peach-tree borer. Not only has it been shown under controlled conditions that the larvae of the Oriental Peach Moth also succumb to the effects of this insecticide[3], but it is a common occurrence to record an abnormally high mortality for larvae on the trunks of trees in orchards where paradichlorobenzene is applied annually which can be ascribed to no other cause.

CONCLUSIONS. These studies, although disclosing the fact that cultivation and the paradichlorobenzene treatment should destroy a high percentage (86%) of the hibernating Oriental Peach Moth, indicate an overwintering population in the upper portions of the tree sufficiently large (14%) to constitute a continuance of infestation from year to year in spite of the thorough application of these measures.

The knowledge of the relatively unprotected character and location of these remaining hibernacula suggests the advisability of further work with insecticides of a penetrating nature, with the attendant possibility of placing the control of the insect largely if not wholly within the dormant period.

MR. H. L. DOZIER: I feel a few remarks here might be appropriate. We in Delaware during the past season have concentrated every effort on the clean-up of the codling moth, and in a study of sources of infestation of that insect, I ran across some interesting data in regard to the oriental peach moth carry-over.

In regard to the question of packing house sanitation or clean-up of old infested baskets, I might state I believe that that probably is one of the big factors which led to a surprising reduction in codling moth in the state of Delaware this year. For example, in one packing house we placed 3000 old five-eighth bushel picking baskets in the packing house cellar and kept everything tight above and below. We curtained off all but two of the cellar windows, so that the moths were mostly attracted to the light coming from these two windows, and we placed fly paper there. This fly paper was examined at intervals and the different proportions of the moths noted. On June 10, from fly paper exposed during the previous forty-eight hours, I counted 535 oriental peach moth adults as against 85 adults of the codling moth.

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[3] *Laspeyresia molesta* Busck as a Quince Pest, E. N. Cory. Jour. Econ. Ent. Vol. 18, No. 1, February, 1925, pp. 199–203 (Tests conducted at temperature of 80°F).

That gives you an insight into just where some of the oriental peach moth is coming from outside of just what goes on around the tree.

Out of these 3000 baskets, I made a count of 389 of them, showing an average infestation per basket of 29.08 and one basket had 118 worms. That shows you that if 3000 baskets averaging nearly 30 worms were allowed to go out into the field or stand around in the open packing house, you would have 90,000 adult moths turned loose right there, and by taking care of them you have a reduction of that many with which to start off the season.

These baskets had been used for a very short period of harvesting some peaches and later used for two months picking late apples. The majority of the oriental peach moth adults coming out of those baskets, I believe, came from infested apples.

Professor Cory will have more to say about that subject in his paper.

In another packing house 3000 baskets were kept very tight, and on a count of 168 of those baskets, they averaged 21.4 to a basket. In a third packing house cellar about a thousand baskets were placed down in the cellar and a count of 100 of those baskets averaged 13.73 worms per basket.

That just gives you some figures on what I believe to be one of the prime factors in the reduction of the codling moth and one that has been often neglected by the entomologists. Pay more attention to the clean-up of the old baskets and I think you will get better results.

FIRST VICE-PRESIDENT C. J. DRAKE: The next paper is by E. N. Cory and H. S. McConnell. Dr. Cory read the paper.

LASPEYRESIA MOLESTA AS AN APPLE PEST

By ERNEST N. CORY and H. S. MCCONNELL, *College Park, Md.*

ABSTRACT

The extent of injury to apples, types of feeding, egg laying habits and late egg parasitism.

Laspeyresia molesta has been reported[1] as a pest of apples but in the experience of the authors has never attained the commercial damage heretofore in Maryland that it has occasioned this past season.

Examination of the orchard at College Park about the first of October showed a peculiar type of injury at the stem end in a large per cent of the cull fruit examined. Frequently this injury was a small split or abraded place near the base of the stem. Sometimes the injury was almost completely hidden by the stem being in contact along one side.

[1]Trans. Peninsula Hort. Society. 1925. p. 61.

In all cases, however, careful examination showed minute particles of frass near the base of the stem.

Further examination disclosed that many fruits had minute particles of frass almost hidden by the calyx lobes. On cutting these injured fruits larvae in all stages, but principally in the early instars, were found. The tunnels were of two types. Usually the larvae burrowed through the fruit towards the seed cavity, sometimes directly; at other times winding channels were cut and often the entire seed capsule was destroyed, together with some of the seeds, as well. The second type followed the characteristic tunnelling of the lesser apple worm just beneath the skin. These areas ran from the size of a dime to mines extending from the stem to near the calyx and involved nearly a quarter of the surface. When more than one larva was present, the apple broke down completely through a combination of soft rots and the feeding by the larvae.

In leaving the fruit the worm usually cuts a sharply defined circular exit hole, often near the stem or calyx end and constructs its hibernaculum in the basin between adjacent fruits or between the slats of the basket or in the pad.

This injury at College led to examination of cull apples from every part of the state except the extreme western counties. The apples showing evidence of worms were cut, the larvae collected and determined. The following table shows the relative proportion of codling moth and oriental fruit moth larvae in cull fruits.

TABLE 1. WORM COUNTS FROM CULL APPLES

No. of orchards	Total fruits	Visibly wormy	No. worms found	*C. pomonella*	*L. molesta*
12	2210	284	104	32	72
		12.8%		31%	69%

Examination of fruit from an experiment conducted at College, in a privately owned orchard, that had not been sprayed for about five years, showed the following ratio between codling moth and oriental fruit moth.

TABLE 2. WORM COUNTS FROM RECORD TREES IN EXPERIMENTAL PLOTS

Total Fruits	*C. pomonella*	*L. molesta*
5939	60	325
Per cent of total	1	5
Ratio	19	81

Another interesting observation on the cull fruit was the presence of eggs and egg shells on a large per cent of the fruit. Many of the eggs

showed evidence of having been parasitized, but our observation on the point was too late to yield the parasite itself. Most of the eggs were on the edge of either the stem or calyx basin.

MR. H. L. DOZIER: I am afraid that I might leave a little different impression than I intended and had better add a few remarks here. That proportion of 535 oriental peach moths to 85 codling moths was on June 10. Two weeks later the proportion of oriental peach moths coming out dwindled and the codling moth increased, so that when you got down to about three weeks later you got the oriental peach moth far less in abundance than the codling moth in the number coming out, showing that the oriental peach moth was much earlier in its habits in coming out in the spring than the codling moth.

MR. ALVAH PETERSON: I would like to make a few statements which will corroborate what Professor Cory has said in respect to infestations of the oriental peach moth in fruits other than peaches. During the past season we examined a number of varieties of apples starting with summer fruit. Practically no oriental peach moth larvae were found in any variety earlier than Staymans. Wormy fruit was collected in the orchard, brought to the laboratory, the larvae removed and the species determined, so far as possible. Larvae removed from Stayman apples from one orchard appeared to be 52 per cent oriental peach moth larvae while in another orchard they ran close to 30 per cent and in another orchard 5 per cent.

Upon examining Kieffer pears close to 75 per cent of the worms removed were oriental peach moth larvae. Quinces ran 100 per cent infested, 5 to 35 larvae per fruit were common.

I would like to ask Professor Cory how early in the season did he start to examine fruit and what were the varieties?

MR. E. N. CORY: These records are based mainly upon Stayman, Jonathan and Delicious. We didn't observe any injury in the early season, and it was only when we began to get our records from our experimental work that we found this injury, and then began to cut the larvae out and determine them.

MR. J. A. MCCARL: I would like to ask Professor Cory just how they determine what larval characteristics they have between the peach moth, codling moth and apple worm. Three years ago I submitted samples and was unable to get a determination.

MR. E. N. CORY: We base our determination upon a key provided by Dr. Garman, While we realize there is no set of characteristics that will

separate the lesser apple worm from the oriental fruit moth, we believe that the matter of size and coloration of the lesser apple worm at that time of the year gives a pretty good determination.

MR. C. R. CUTRIGHT: I would like to ask if there is any difference in the degree of infestation between the different varieties.

MR. E. N. CORY: I don't believe there is any difference in those varieties that I mentioned. There is a difference apparently in the varieties that are known as winter apples. We had other apples in there; we had York Imperial and a number of others in lesser quantities, but there didn't seem to be very much difference between the grade of infestation, for instance, in Stayman and Jonathan. We had a fewer number of Delicious, and it would be hardly fair to say whether there was a difference there or not, but with the Jonathan and Stayman we had enough of equal distribution; I think there is no difference between those two. We also found infestation in Grimes and in Golden Delicious, but we didn't include those in these records.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by T. L. Guyton.

NOTES ON THE OCCURRENCE OF *LUPERODES THORASICUS* AS AN INSECT PEST OF FRUIT TREES

By T. L. GUYTON, *Bureau of Plant Industry, Harrisburg, Pa.*

ABSTRACT

Luperodes thorasicus, a small, dark beetle formerly not known to occur in numbers sufficient to cause any economic concern was found in an orchard in the central part of Pennsylvania doing damage to the foliage of peach, apple and plum, and damaging slightly the fruit of apple. The owner of the orchard reported that the insect had been present for three or four years, and was increasing in numbers. A survey of the surroundings of the orchard showed the insect to be present on butternut (*Juglans cinerea*), and cultivated blackberries. Since the regular apple spray schedule was fairly closely followed in this orchard it may be that should this beetle increase it might become a serious pest in our orchards. The life history of the insect is not known.

In 1925 correspondence was received from Mr. George Lincoln of Clarks Summit, Pa., to the effect that an unknown beetle was causing him serious damage by feeding on the leaves of apple and young peach. He, also, said that the insect was attacking the fruit of apple. Again in 1926, Mr. Lincoln wrote to the department stating that the insect was appearing in large numbers again. On July 19th the orchard was visited. The beetles were found on the foliage of peach, apple and plum in rather abundant numbers. It was doing considerable damage to the foliage of peach, slightly less on certain apple trees, and but little

on the European plums. The fruit of one variety of apples, the Alexander, was considerably marked by feeding of the beetles. Some beetles were taken by beating with an insect net in the weed patches on the border of the orchard; and several specimens were found on the blackberry. They were rather numerous on the foliage of the white walnut, (*Juglans cinerea*). Mr. Lincoln said this insect had been present in his orchard for three or four years, and he believed that it was increasing in numbers. The orchard is in a sod mulch, is of about ten acres in area, and is bordered on one side by a strip of woodland in which a number of butternuts are growing. There are, also, large numbers of blackberries growing in and near the orchard. The orchard was sprayed at regular intervals following out the standard spray schedule for apples. The peach trees affected were small, being two years planted.

The identification of the species as *Luperodes thorasicus* Melsh. was made by Mr. A. B. Champlain of the Bureau of Plant Industry, and specimens were sent to the United States Department of Agriculture at Washington for confirmation. The species was described by Melsheimer in 1847 from specimens taken in Pennsylvania. LeConte in 1865 gave the distribution as Pennsylvania, Georgia, and Kansas and the occurrence rare. Horn in 1893 states that the species is widely distributed, but does not seem common. He gives its distribution as Pennsylvania, Maryland, Georgia, and Kansas. The writer was unable to find any other references to the species. It may be that this species is capable of becoming a serious pest in orchards since it was present in this case in rather large numbers in spite of the fact that the orchard had been well sprayed with the regular apple orchard sprays.

FIRST VICE-PRESIDENT C. J. DRAKE: We wiill now listen to a paper by G. A. Runner and J. R. Eyer. Mr. Eyer will read the paper.

EXPERIMENTS IN CONTROL OF THE ROSE-CHAFER, *MACRODACTYLUS SUBSPINOSUS* FAB., IN VINEYARDS

By G. A. RUNNER, *U. S. Bureau of Entomology* and J. R. EYER, *Pennsylvania Bureau of Plant Industry*

ABSTRACT

During the last four years cooperative experiments have been carried on in Ohio and Pennsylvania in which some of the more recently developed insecticides were tested and compared with the arsenate of lead and molasses mixture ordinarily used for rose-chafer control. The following materials were included: emulsions of pyrethrum, ortho-

toluidine, and lubricating oils; lime sulfur in dust and liquid form; sodium fluosilicate; nicotine and tobacco dusts; coated (oleate), arsenate of lead, colloidal arsenate of lead, and dry arsenate of lead alone and in combination with Bordeaux mixture, wheat flour, molasses, and confectioner's glucose. Two methods were used to ascertain the effectiveness of these materials: (1) counts of the number of living adults were made on selected vines in each plot before applying the insecticides and these were repeated each day for a period of one or two weeks, depending on period of activity; (2) equal numbers of adults were placed in cages on vines in each plot and the living and dead recorded each day. The amount of injury due to feeding was also noted.

All of the arsenicals tested were toxic to the rose-chafer when used in sufficient amounts. Many of them did not protect the fruit and foliage from feeding injury because the adults ate large quantities of the leaves and fruit clusters before ingesting sufficient aresnic to kill them. In the case of arsenate of lead and molasses the beetles consumed toxic quantities without injuring the fruit or foliage and protection to the vineyard was almost perfect. With both arsenate of lead and flour, and coated (oleate) lead arsenate similar behavior was noted. Arsenate of lead: 4 lb., molasses: 2 gal., and water: 100 gal., killed caged adults in 24–48 hours and reduced infestation in the vineyard to an inappreciable amount. Doubling the amount of the arsenical increased the death rate in caged material but afforded no additional protection in the field. The time for applying these arsenicals proved exceedingly important. The best control was secured by spraying when the adults first migrated into the vineyard and commenced feeding. Weather factors, particularly low temperatures, also influenced the control obtained from the sprays.

Dusts of sodium fluosilicate and hydrated lime or talc were only slowly toxic, did not protect the vines against feeding, and burned the foliage unless large quantities of the diluent were used. Pyrethrum soap emulsion was highly toxic and killed 80–100 per cent of the beetles in twenty-four hours after spraying. It did not prevent injury to the vines from incoming migrants however. Orthotoluidine emulsion was more slowly toxic requiring several days to kill caged adults. The other materials tested were only doubtfully effective or entirely valueless.

A number of attrahents including essential oils, alcohols, and fruit juices were exposed in bait pans in infested vineyards. The rose-chafer was attracted by none of these materials.

First Vice-President C. J. Drake: The next paper is by Philip Garman.

THE PROBLEM OF CURCULIO CONTROL IN CONNECTICUT APPLE ORCHARDS

By PHILIP GARMAN

ABSTRACT

This paper treats of field experiments and observations showing different phases of curculio (*Conotrachelus nenuphar*) control, especially comparisons of seven-day applications with other schedules from which this spray is omitted. Figures show a small, consistent gain in clean fruit where the seven-day application was included in the schedule over those in which it is omitted. Other spray schedules are also compared and percentages tabulated. A variation of about ten per cent clean fruit was obtained by the different treatments, which was, however, very small and of doubtful importance in many cases. Some data indicate that fish oil used as a sticker at the calyx period gave almost as good results as where the complete schedule was used, and it appears possible to lessen the number of sprays for curculio control by this means.

Several years ago the Connecticut Station began a study of curculio control in order to fit methods of practice more closely to field conditions. It has been noted in various local experiments that a large per cent of the fruit, especially on outside rows, was often damaged even with the best methods of control available. Consequently investigations were begun along the lines needed to determine (1) the source or sources of the infestation and the time when it is at its height, and (2) the proper means of reducing it to a minimum.

Counts were made of drop fruits and beetles were reared from them, the number of larvae obtained indicating enough development in early drops to produce an ample supply of beetles the following year. Investigation of woods near apple orchards usually showed the presence of wild apples supplying additional beetles to the orchards in question. Our records indicate that beetles emerge from the soil beginning the latter part of April and continuing well into June—or in terms of the development of the tree they begin to emerge shortly before the blossom buds of most varieties turn pink, and continue at least two weeks after the petals have fallen. Our jarring records, however, indicate that they do not appear on the trees until shortly before the petals fall, and it has naturally occurred to us to ask this question—what is the value of poison for curculios applied at the pink bud period? By a continuation of jarring it has become apparent that the maximum abundance of beetles[1] on the trees in Connecticut may lie at least three weeks after the calyx or petal fall spray and we were led by these results to raise the second question—why should sprays grouped on the early side of the peak

[1]These data seem to correspond with data given by Quaintance, U. S. D. A. Bull. 103, p. 121, 1912.

provide greater protection than sprays grouped so as to spread the applications over the entire period of activity? We have attempted to answer these questions by means of spray schedules in which one after another of the important sprays were dropped, in order to determine what would be the effect upon the amount of clean fruit. The results of these experiments are shown in Tables 1–5. In view of the recent development of more efficient stickers, we have also considered the question of introducing one of these at a given point in the schedule (the calyx spray period) and noting results. Thus far they appear to be promising, as will be seen in Tables 3 and 5, and it seems reasonable to expect that something of this sort will result in the elimination of at least one of the early sprays from the schedule now recommended. In comparison of results in Table 5 it will be noted that there has been for three years a consistent advantage of two to nine per cent in favor of the 7-day practice schedule over that in which it is omitted. There seems to be a difference of opinion as to whether such an increase, in which the damage consists of one or two external scars per apple, will justify the expense of an extra application. Whether it is justified or not will, of course, depend upon the amount of fruit borne by the orchard in question, the market price of the scarred and first grade fruit, and finally the price of labor and materials. Other factors also enter the problem, namely the degree of increased control of other pests and the thoroughness with which the orchardist applies his materials. It does not seem justified in Connecticut at the present time except in the case of the best varieties of fruit and a large crop.

EXPLANATION OF TABLES. All spraying was done with rods, applying 8 to 14 gallons per tree. Trees in the orchards used were set about 1911. No counts are recorded where the apple crop consisted of less than a thousand fruits, the maximum in some cases reaching 54,000. The different treatments recorded as "no pink," "no calyx," etc. indicate omission of these sprays from the usual schedule. The figures in Tables 1 and 2 under "total per cent clean" are not the average of the drop and picked fruit percentages, but are figured on the basis of total fruits scored. The spray formulae used in each case consisted of the following except where indicated in the tables.

FORMULA NO. 1

Lead arsenate	3 pounds
Nicotine sulphate	1 pint
Casein lime	1 pound
Lime sulphur (dry)	6 pounds
Water	100 gallons

FORMULA No. 2

Fish oil	1 quart
Lead arsenate	3 pounds
Water	100 gallons

No nicotine sulphate was used in any of the treatments in 1926. No lime-sulphur, or nicotine sulphate, or casein lime was used in any application containing fish oil.

Equal credit for the work herein reported is due to Mr. M. P. Zappe of the Connecticut Experiment Station, who has given much time, thought, and energy to the project.

TABLE 1. SHOWING COMPARISON OF DIFFERENT SPRAY TREATMENTS

1924

Treatment	Kind of fruit	Per cent clean	Total per cent clean
No pink spray;	Drops	62.5	
Calyx, 7-day, and 2-weeks	Picked	83.9	80.5
No calyx spray;	Drops	61.6	
Pink, 7-day, and 2-weeks	Picked	82.5	72.2
No 7-day spray;	Drops	85.2	
Pink, calyx, and 2-weeks	Picked	85.6	85.5
No 2-weeks spray;	Drops	60.0	
Pink, calyx, and 7-day	Picked	88.8	82.68
All sprays;	Drops	80.1	
Pink, calyx, 7-day, and 2-weeks	Picked	90.7	86.8
Check; no spray	Drops	31.6	
	Picked	39.1	35.9

TABLE 2. SHOWING COMPARISON OF DIFFERENT SPRAY TREATMENTS

1925

Treatment	Kind of fruit	Per cent clean	Total per cent clean
No calyx;	Drops	94.35	
Pink, 7-day, and 2-weeks	Picked	90.39	91.04
No 7-day;	Drops	83.07	
Pink, calyx, and 2-weeks	Picked	85.54	84.80
No 7-day;	Drops	95.60	
Pink, calyx with fish oil, 2-weeks	Picked	93.30	93.93
No 7-day; Pink, heavy dose[1]	Drops	41.66	
Lead arsenate at calyx and 2-weeks	Picked	91.47	88.33
No 2-weeks;	Drops	81.21	
Pink, calyx, and 7-day	Picked	92.34	89.66
All sprays;	Drops	92.08	
Pink, calyx, 7-day, and 2-weeks	Picked	94.60	93.77
Check; No treatment	Drops	43.98	
	Picked	35.66	38.78

[1]6 pounds per 100 gallons.

TABLE 3. SHOWING COMPARISON OF DIFFERENT SPRAY TREATMENTS
1926. Picked Fruit

Treatment	Per cent clean
No pink; calyx, 7-day, and 2-weeks	95.4
No calyx; pink, 4 days after calyx, 5 days later, 12 days after 5-day	90.6
No 7-day; pink, calyx, and 2-weeks	94.6
No 7-day; pink, calyx, with fish oil, 2-weeks	95.3
No 7-day or 2-weeks; pink, calyx with fish oil, nothing after calyx	96.8
All sprays; pink, calyx, 7-day and 2-weeks	96.7
Check; no treatment	50.7

TABLE 4. SHOWING COMPARISON OF 7-DAY SPRAY WITH A SPRAY APPLIED AFTER THE REGULAR SCHEDULE

Treatment	Per cent clean
1925	
7-day; pink, calyx, 7-day, and 2-weeks	79.27
5 weeks; pink, calyx, 2-weeks, and 5-weeks	72.57
Check; no treatment	22.08
1926	
7-day; pink, calyx, 7-day, and 2-weeks	96.5
4-weeks; pink, calyx, 2-weeks, and 4-weeks	96.7
Check; no treatment	73.4

TABLE 5. SHOWING RESULTS OF DIFFERENT SPRAYS FOR CURCULIO CONTROL
1924, 1925 and 1926
Picked Fruit Only

Treatment	Per cent clean fruit		
	1924	1925	1926
Orchard A			
No pink; calyx, 7-day, 2-weeks	83.9		95.4
No calyx; pink, 7-day, 2-weeks	82.5	90.4	
No 7-day; pink, calyx, and 2-weeks	85.6	85.54	94.6
No 2-weeks; pink, calyx, and 7-day	88.8	92.3	
All sprays; pink, calyx, 7-day, and 2-weeks	90.7	94.6	96.66
Check; no treatment	39.1	35.6	50.7
No 7-day; fish oil plus lead arsenate at calxy (pink, calyx and 2-weeks)		93.3	95.3
Orchard B			
5-weeks spray; pink, calyx, 2-weeks, 5-weeks		72.5	
4-weeks spray; pink, calyx, 2-weeks, 4-weeks			96.7
Pink, calyx, 7-day and 2-weeks		79.2	96.5
Check; no treatment		22.08	73.4

MR. G. M. LIST: In this connection I would like to mention a little experience we have been having with this same insect in Colorado. For a number of years we have been watching it on the wild cherry in our foothills and to some extent on the sour cherries growing in orchards near the foothills. Two or three different times we have had it de-

termined as this species. We have been inclined to doubt the exact determination, but this year we had over twelve acres of cherries that were a total loss. As soon as the fruits were punctured by the adults, they, of course, were immediately attacked by bees and various flies and the orchard was simply humming with the insects.

I am wondering if any of the others have had experience with this in stone fruit. It was quite alarming to us in the cherry growing section there.

I might correct a wrong impression that I probably gave. When the speaker was speaking about the curculio in the apple, I thought, (being from the West) of the apple curculio, but I understand he was speaking of the plum curculio.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by H. J. Quayle.

CYANIDE DUST FUMIGATION

By H. J. QUAYLE, *University of California, Citrus Experiment Station, Riverside, California*

ABSTRACT

In recent years new forms of cyanide have been developed which are known as cyanides of calcium. Such compounds are more or less unstable and advantage is taken of this property by simply exposing them, in a finely divided form, to the atmosphere in order to have hydrocyanic acid gas liberated. This method of fumigation particularly as applied to citrus was developed by the writer in California in 1922 and in the following year he introduced it into Australia where it has now largely replaced the older methods of fumigation. It is also used as an effective method of controlling the rabbit which is the leading pest of that country. During the past year a practically pure calcium cyanide has appeared which overcomes the chief objection to the first material in that the dust residue is not so injurious to the tree in sections having a moist atmosphere. Hydrocyanic acid in dust form escapes through canvas covers less readily than does the same gas from liquid hydrocyanic acid. The method of application is simply to blow the cyanide dust under the tented tree or space and the moisture of the air in contact with the dust particles generates the gas.

The form of cyanide first used for the fumigation of plants was potassium cyanide and this salt continued to be used exclusively for such purposes although the sodium salt was at the same time largely used in the industries. The late adoption of sodium cyanide for plant fumigation was probably due to the fact that it contained more or less sodium chloride which, as in the fumigation of plants hydrocyanic acid gas is the end sought for, resulted in the decomposition of a portion of this gas.

More recently other forms of cyanide adapted for fumigation purposes have appeared and in these the cyanogen is combined chiefly with

calcium rather than with potassium or sodium. Cyanides of calcium differ from the other cyanides heretofore used for fumigation in that hydrocyanic acid is freely liberated simply on exposure to the atmosphere. This less stable nature of the calcium cyanides makes them much more convenient for many kinds of fumigation work because the addition of sulfuric acid and water is unnecessary.

The first of these compounds is formed by the fusion of cyanamid with common salt. Upon learning in June 1922, that HCN gas was given off from the crude material, which is in the form of flakes, in sufficient amount to kill rodents it occurred to the writer that if the flakes were ground into a fine powder the liberation of the gas might be sufficiently rapid to be applicable for the fumigation of citrus trees; and providing furthermore that the dust residue would not be injurious. The first tests carried on during the dryer part of the year in southern California were successful, but under more moist conditions too much injury to the tree occurred, particularly with the lemon. It is a curious fact that while the lemon is much more resistant to HCN gas than the orange, with this method of calcium cyanide dust fumigation, the lemon is the more susceptible. The calcium cyanide which is now known on the market as cyanogas calcium cyanide contains a considerable amount of common salt, calcium carbide and other impurities.

In 1923 the writer had the privilege of trying the dust method of fumigation with cyanogas calcium cyanide under Australian conditions. A considerable portion of the citrus area in that country is probably under dryer conditions than that of southern California, which would account for the fact that 300,000 citrus trees were successfully fumigated by the dust method in that country last year.

No one is long in Australia before he appreciates the great importance of the rabbit problem, and it seemed to me that cyanide dust gave promise of being a satisfactory fumigant. Carbon disulphide was the chief fumigant heretofore used. In fumigatorium experiments where ounces by weight of the cyanide were compared with fluid ounces of carbon disulphide, it was found that the cyanide was 35 times more deadly on the rabbits than the carbon. That is, if 1 fluid ounce of carbon disulphide was necessary to kill in a certain enclosed space only 1/35 of an ounce of the cyanide was necessary. In the use of carbon disulphide a smoke formed by an acid and ammonia is first pumped into the burrows to indicate the connecting openings. After these are closed the carbon disulphide is pumped in. In case of the cyanide when it is blown into the burrows the fine dust soon appears at the surface of all connecting burrows, so that the cyanide dust acts not only as the killing agent but

is also an indicator for open burrows. Calcium cyanide dust fumigation has proved to be an effective method of controlling the rabbit in Australia and a good many tons of the material are now used there annually.

But I am getting far afield, since citrus fumigation was my main problem. Further work with citrus dust fumigation was given up in California because under the best methods the hazard to the tree is great enough. However, during the past year another calcium cyanide compound in the form of a very fine powder has appeared. This product is formed by combining liquid hydrocyanic acid with calcium carbide. Since this is practically a pure calcium cyanide and the residue therefore should be less harmful to the tree, work on dust fumigation for citrus trees was resumed. This product, $Ca(CN)_2$, which is now known on the market as "citrofume" contains 30 per cent HCN. On exposure to the air HCN gas is given off rapidly. Where it was blown under a tent and collected on paper 93 per cent of the total gas was liberated within five minutes, 98 per cent in twenty minutes, and 99 per cent in forty-five minutes when the relative humidity was 57–58 per cent and the temperature 71°–74°F. When the relative humidity was 20–22 per cent, 90 per cent of the gas was liberated at five minutes, about 96 per cent at twenty minutes, and 98 per cent at forty-five minutes. The low relative humidity 20–22 per cent, had no marked effect on the evolution of gas from the citrofume but this humidity retarded considerably the evolution of the gas from cyanogas calcium cyanide.

Work with both of these dust cyanides has indicated that a less actual amount of HCN is necessary to put under the tent than is the case with the use of liquid HCN. Judging from the kill of scale alone it was thought that the distribution of the dust particles and the generation of HCN gas from them, often in close proximity to the scales, largely accounted for this fact. But by aspirating a quantity of air from under the tent at different places and at different times, and determining the actual amount of HCN gas present it appears that less of the gas goes out through the tent where it comes from the dust than where it comes from the liquid.

For example a considerable number of field tests have shown that 1¼ ounces of $Ca(CN)_2$ (30 per cent HCN), so far as the actual mean gas concentration and the kill of scale under a tented tree are concerned, are equal to 20cc. of liquid HCN of 97–98 per cent purity. One and one-fourth ounces of this calcium cyanide would also equal about 1 ounce of sodium cyanide (51–52 per cent cyanogen). In the amount of calcium cyanide given there is about ¼ less HCN than in the amount of liquid given. If the mean concentration of HCN gas under the tent is the

same when these ratios are used then there must be less escape of gas in one case than in the other. Where a gas tight fumigatorium is used for the comparisons the differential indicated does not appear. That is, in order to secure the same mean concentration of gas in a tight box or room the equivalents of HCN must be carried in both the dust and liquid when the charge is given. Why HCN gas does not escape through the tent as readily in one case as in the other is largely speculative at the present time.

Another grade of $Ca(CN)_2$ carrying 50 per cent of HCN or "Calcyanide" has been tested to some extent for citrus fumigation, although at present it is prepared primarily for ware-house fumigation. Evolution of the gas is more rapid than with the lower grade or 30 per cent material. The higher grade or 50 per cent material would probably be preferable even for citrus fumigation, chiefly because there would be less bulk to handle, but thus far commercial citrus fumigation has been carried on with the 30 per cent material.

Calcium cyanide $Ca(CN)_2$ "citrofume" is well adapted for citrus and other fumigation because (1) HCN gas is readily and very completely evolved during the exposure period of 45 to 60 minutes, (2) it is in a fine state of division, thus insuring good distribution under the tent, (3) the residue is practically harmless, (4) it can be stored and kept indefinitely in air tight containers, (5) it is useful for occasional fumigation about any premises because it may be on hand and is simple to apply. (6) It is safe to handle and to transport. This is the important comparison in relation to liquid HCN; and in relation to the pot system, and the use of acid and water, convenience is the important consideration.

In citrus fumigation, by means of a hand applicator, the proper dosage is given by weight and the material is then blown under the tent by a foot bellows. This applicator has been largely discarded, however, for a power applicator which consists of a Ford chassis on which is mounted the weighing device and a pump operated by power taken from the Ford engine. A good many thousand pounds of material were used in this method of fumigation in California during the past year.

MR. C. A. WEIGEL: How much air is aspirated?

MR. H. J. QUAYLE: We aspirate three liters from three different points in the tree, and five of these aspirations are made during a period of forty minutes.

FIRST VICE-PRESIDENT C. J. DRAKE: Mr. Hartzell has come into the room so I will call for his paper.

THE ARSENIC CONTENT OF SPRAYED APPLES

By ALBERT HARTZELL and FRANK WILCOXON, *Boyce Thompson Institute for Plant Research, Inc., Yonkers, New York.*

ABSTRACT

Individual analyses of 47 apples from trees sprayed according to the standard schedule comprising 5 applications of lead arsenate (4 lbs. to 150 gals.) at Yonkers, New York, during the season of 1926, gave an average of .173 mg. of arsenic trioxide per kg. of fruit and a maximum of .704 mg. per kg. The quantity allowed by the Royal Commission on Arsenical Poisoning in 1903, was 1.429 mg. per kg. of foodstuffs. There was between 17.85 and 19.51 inches of rainfall from the time the first spray was applied until the date the fruit was picked. Analyses of cider (50 cc.) and jelly (30 g.) made from apples from this experiment, showed arsenic in such minute quantities that the determinations did not differ from the blanks of the reagents by any measurable amounts.

Recently anxiety has arisen in England regarding the safety of sprayed fruit for human consumption. In that country fruit trees are sprayed when the blossoms are in the pink bud stage and sometimes immediately after the petals fall, or rarely a little later, but the frequent applications of arsenicals, as is common in the United States and Canada, is not the practice there. Apples showing spray residue began to attract the attention of the public and questions were asked in the House of Commons as to the danger of using such fruit. The Ministry of Agriculture (1) had a number of samples analyzed from England, Canada, and the United States. Of the 24 samples reported, one from British Columbia contained more arsenic trioxide than 1/100 grain per pound (1.429 mg. per kg.), the limit suggested by the Royal Commission on Arsenical Poisoning in 1903. The subject has been discussed at considerable length in newspapers and trade journals (2) and has led to a more stringent enforcement of the regulatory measures in the United States and abroad. The question of whether the amount of arsenic that remains on sprayed fruit at harvest time is sufficient to endanger public health and therefore necessitate a change in our spray program, is one of prime importance to the consumer, the fruitgrower and the entomologist. The present study is an attempt to briefly summarize our knowledge to date regarding arsenical residue on apples and present, in addition, the results of one season's work on analyses made of apple stems, peel, and calyx ends that received a definite spray schedule containing a known amount of lead arsenate and that were exposed to the rainfall during the season of 1926, of which records are available.

Le Baron (3) was the first to recommend the application of Paris green to fruit trees for the control of the spring canker worm, but spraying did not become a general practice until after 1887.

Cook (4) found no trace of arsenic in 100 blossom ends that were removed from the trees on August 19, that had been sprayed 4 to 5 weeks previously with London purple at the rate of one pound to 100 gallons of water.

In like manner Garman (5) obtained negative results from analyses of skins and ends of apples that had been sprayed with a single application of Paris green and 5 applications of London purple at the rate of one pound to 160 gallons of water.

In Europe the controversy over the use of arsenicals centered around the possible danger of the contamination of wine and considerable literature has been developed on this phase of the subject which need not be discussed here. The ordinance of 1846 prohibited the use of arsenicals in France but this seems not to have been enforced. After much controversy the Ministry of Interior in 1913, submitted to the Academy of Medicine a draft of a decree modifying the ordinance of 1846 and permitting the use of insoluble arsenates in agriculture under regulation, but prohibiting the application of soluble arsenical insecticides (6). This decree was presently put into effect.

Forbes (7) reported 36.6 and 32.9 parts per million of arsenic trioxide respectively from apple peel that had been sprayed with lead arsenate the previous day, and [illegible] parts per million from the skins of fruit picked two months after h[illegible] spraying with lead arsenate.

Günther (8) found 0.057 mg. arsenic trioxide per 100 g. (0.57 mg. per kg.) of fruit from apples sprayed with a mixture of 300 g. of sodium arsenite and 425 g. of lead acetate per 100 liters. He also reported results of analyses of apples that had been dusted with a mixture containing 2 parts of freshly slaked lime, 4 parts of sulfur, and 1 part Paris green. The arsenical content of the dusted fruit ranged from 0.420 mg. to 0.0084 mg. of arsenic trioxide (0.42–0.08 mg. per kg.). In both cases the materials had been applied from 80 to 160 days previous to analysis.

Brioux and Griffon (9) reported in September only a trace of arsenic from apples, and the cider made therefrom, that had been sprayed with lead arsenate on June 8 and 22. Representative samples taken in July showed on analysis 1.3 mg. arsenic trioxide per kilogram of fruit.

Amphola and Tommasi (10) state that food stuffs derived from plants sprayed with arsenicals always contain arsenic, usually in traces, but sometimes with fruit the amount may be as high as 2 mg. per kg.

Sonntag (11) concluded from the results on ripe fruit treated with arsenical mixtures, that sprays or dusts applied to fruit trees adhere to the fruit and are retained for a long time, in many cases until the ripening of the fruit. He recovered arsenic trioxide in weighable amounts from

fruit sprayed twice with Bordeaux-arsenate 87 days later, and from apples and pears 80 days after spraying with lead arsenate. With arsenical dusts appreciable amounts of arsenic trioxide were obtained 106 days after dusting. The results of his analyses appear to be somewhat higher than those obtained by any other investigator, although the fruit had been exposed to a number of rains before picking.

O'Gara (12) found that skins of apples will occasionally absorb arsenic, noticeable in the form of red or black spots, which upon analysis showed fractions of a milligram of arsenic.

Woods' (13) analyses indicate an average of .5372 mg. per kg. of arsenic trioxide per apple from washings of fruit that was sprayed in August and picked two months later. He concludes that the amount of arsenic that will remain on fruit at the end of this period is so slight as to have no practical bearing.

O'Kane, Hadley, and Osgood (14) recorded the following amounts of arsenic trioxide on apples that had been sprayed with lead arsenate at the rate of 3 pounds of the paste to 50 gallons of water: apples picked carefully 0.08 mg. to 0.77 mg.; 0.02 mg. to 0.50 mg. when picked in the ordinary way; 0.10 mg. to 0.21 mg. when picked with cotton gloves; and 0.08 mg. to 0.18 mg. when picked with cotton gloves and wiped. The maximum amount of lead arsenate, when sprayed directly, that would adhere to an apple, was found to be 4 mg., expressed as arsenic trioxide.

Lynch, McDonnell, Haywood, Quaintance, and Waite (15) conclude from the results of a large number of analyses of sprayed fruits that it is important to follow the spray schedule recommended by the U. S. Bureaus of Entomology and Plant Industry if excessive amounts of spray residue are to be avoided and when this schedule is followed there is little spray residue remaining on the fruit at harvest time. They found that in peeling the fruit practically all the spray residue was removed.

Sutton (16) found that when apple trees in Western Australia were sprayed as late as November with 12½ pounds of lead arsenate to 100 gallons of water, using flour as a spreader, the fruit when examined in February showed a maximum only of 1/8 of the minimum set by the British Ministry of Health (1/100 grain per pound). It was greatest when the largest amount of flour was used as a spreader. Where trees were sprayed 5 times with 6 pounds of lead arsenate in 100 gallons of water, with a calcium caseinate spreader, and the last spray applied in December, the amount of arsenic trioxide found varied from 1/110 to

1/800 grain per pound (0.013 mg. to 0.002 mg. per kg.). He states that the amount of rainfall after spraying was comparatively light.

Plan of Experiment

In order that the results would be significant for fruit growers in the vicinity of Yonkers, the strength of spray materials and the time of application of the sprays were made to conform as nearly as possible with those recommended by the local spray service. Twenty mature Greening apple trees were included in the test. Five regular spray applications were made, namely, the delayed dormant, blossom pink, calyx, two weeks and mid-summer. Grasselli powdered lead arsenate[1] at the rate of 4 pounds to 150 gallons of spray solution was used in all the applications. Lime-sulfur was used in the first four, but omitted from the last application, because scab infestation was light, practically none developing on the unsprayed trees. Full strength lime-sulfur 1–8, with a hydrometer reading of 1.03 sp. gr., was used for the delayed dormant and for the other three applications summer strength 1–40 (1.008 sp. gr.). Two pounds of calcium caseinate and 1½ pints of nicotine sulfate to 150 gallons of spray solution were included in all 5 applications. The spray ingredients were mixed in the following order: water, lime-sulfur, calcium caseinate, lead arsenate, and nicotine sulfate. The following schedule represents the spray program for this experiment. Owing to adverse weather conditions the "two weeks" spray was applied later than usual.

1926 Spray Program, Yonkers, New York

Period of spraying	Date of application	Materials in spray mixture
1. Delayed Dormant	April 22	Lime-sulfur, 15 gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.
2. Blossom Pink	May 11	Lime-sulfur, 3½ gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.
3. Calyx	May 25	Lime-sulfur, 3½ gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.

[1] A sample of the lead arsenate used in this experiment was found on analysis to contain 21.6 per cent metallic arsenic.

4. Two weeks	June 17	Lime-sulfur, 3½ gals. Calcium caseinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.
5. Mid-summer	July 19	Calcium casinate, 2 lbs. Lead arsenate, 4 lbs. Nicotine sulfate, 1½ pts. Water to make 150 gals.

The sprays were applied by means of a 6 H.P. Friend sprayer. Spraying was done from the ground using a Friend gun, developing a pressure of 250 pounds at the nozzle. The trees averaged about 20 feet in height and the amount of spray applied per tree was approximately 25 gallons for each application. Insects were not unusually severe. The sprays gave a 97% control of codling moth which was the principal insect trouble. On September 14, 100 apples were picked from the upper branches of the sprayed trees; none were taken less than 12 feet from the ground. These are designated as series 1. A month later, series 2, consisting of 100 apples, was picked from the lower branches of the sprayed trees, within 8 feet from the ground. Care was exercised in picking to avoid unnecessary handling so as not to remove the spray residue. To prevent any loss in weight due to respiration, the apples were placed in cold storage at a temperature of 5°C. until they were ready to be prepared for analysis.

Climatic Factors

The spring of 1926 was unusually dry, the local weather records showing only 4 rainy days at Yonkers for the month of April; contrasted with this was the rather heavy precipitation during mid-summer and fall. From the time of the first spray, the delayed dormant application, which was made April 22, until September 14, when the first apples were picked (series 1), a total of 17.85 inches of rain fell. The total precipitation from July 19, the date of the last spray, until the time of picking, was 9.71 inches. The apples in series 2, which were picked a month later than those in series 1, were exposed to 19.51 inches of rainfall from the date that the first spray was applied to the time of picking, while the precipitation recorded for the time intervening between the last spray and the time of harvest for this series, was 11.37 inches. The daily precipitation, dates of spraying, and the length of time the apples were exposed to rainfall after spraying, are shown graphically in figure 9. The rather heavy rainfall during the latter part of this season must be taken into account in making comparisons of arsenic content of fruit. The results

Fig. 9.—Graph showing dates of spraying, daily precipitation and time of sampling. Horizontal lines opposite Roman numerals indicate respectively the length of time the apples in series I and II remained on the trees.

are probably somewhat lower than would be expected for a season of normal precipitation, while during a dry fall, fruit would doubtless show a considerably higher arsenic content than was obtained this year.

Method of Analysis

It was desired to determine the arsenic content of individual apples rather than that of a sample containing a number of apples, since in the latter case unusually high values for a single apple might escape notice. As the quantity of arsenic on any one apple was very small, it was necessary to use a colorimetric method for its estimation. From each series 24 apples were selected at random, weighed and carefully peeled. Included with the peel was the stem and calyx, which were placed immediately in a Kjeldahl flask and digested with sulfuric and nitric acids until all organic matter was destroyed. After heating until fumes of sulfur trioxide were given off, the solution was diluted to 100cc. and 25cc. portions taken for the determination of arsenic by the modified Gutzeit method as described in Scott's "Standard Methods of Chemical Analysis."[2] Blank determinations were made on the reagents used, as well as on apples which had never received an arsenic spray, and a series of standards was prepared using the peel of unsprayed apples to which varying amounts of a standard solution of sodium arsenite were added. The blank on the reagents was small (0.001 mg. arsenic trioxide) and that on the unsprayed apples did not differ from it by any measurable amount. Using the smaller Gutzeit apparatus, it was possible to detect differences of 0.002 mg. of arsenic trioxide. The mean value for a single apple was approximately 0.026 mg.

Results

The results of the determinations were calculated to mg. arsenic trioxide per kg. of fruit and are given in Table 1.

In order to test the possibility of arsenic contamination of apple products, samples of jelly and cider were made. Ten unwashed apples from series 2 were carefully peeled and jelly made from the skins and cores according to the usual household method. Cider was made from 12 unwashed apples from the same series. A 30 g. sample of the jelly was used for analysis and a 50cc. sample of the cider. For comparison, cider (50cc. sample) from a commercial cider mill, made of sprayed apples from a local orchard, was also examined. The results of the examination in no case showed amounts of arsenic significantly greater than the blanks of the reagents.

[2]Scott, W. W. Standard Methods of Chemical Analysis, p. 40, D. Van Nostrand Company, 2nd Edition, 1918.

TABLE 1. ANALYSES OF ARSENIC REMAINING ON INDIVIDUAL APPLES AT PICKING TIME

Series 1 Apples taken from upper branches			Series 2[3] Apples taken from lower branches		
wt. grams	mg. As_2O_3 per apple	mg. As_2O_3 per kg. fruit	wt. grams	mg. As_2O_3 per apple	mg. As_2O_3 per kg. fruit
149	.003	.020	150	.004	.027
103	.020	.194	183	.012	.065
144	.015	.104	200	.050	.250
154	.006	.039	125	.016	.128
207	.006	.029	182	.024	.132
152	.005	.033	202	.004	.019
155	.075	.484	176	.024	.136
131	.010	.076	143	.048	.336
105	Trace	—	142	.100	.704
126	.015	.119	150	.068	.454
107	.012	.112	165	.048	.290
171	Trace	—	125	.060	.480
141	.008	.056	139	.060	.432
170	.030	.177	159	.008	.050
174	.008	.046	147	.060	.408
152	.020	.132	178	.008	.045
172	.040	.233	165	.024	.145
217	.008	.036	178	.032	.180
107	.030	.280	159	.050	.314
90	.032	.356	122	.004	.033
81	.010	.123	210	.100	.476
102	.002	.019	200	.024	.120
119	.004	.033	187	.040	.214
102	.004	.039			

CONCLUSION

It was found that apples sprayed this season according to a standard schedule, for this vicinity, contained arsenic in amounts considerably below the limit adopted by the Royal Commission on Arsenical Poisoning in 1903. The amount of arsenic from food products made from these apples was even less than that found in the original apples.

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[3]Series 2 consisted originally of 24 samples but one sample was lost on analysis.

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MR. E. R. VAN LEEUWEN: I should like to know how the samples were selected?

MR. ALBERT HARTZELL: We got a ladder, picked the apples and carefully handled them so as not to rub off too much of the arsenic. We tried to follow the method described by Professor O'Kane for ordinary picking.

MR. E. R. VAN LEEUWEN: Do you select the apple with the heaviest application on it?

MR. ALBERT HARTZELL: No. We tried to do that, but we found you can't always tell whether an apple has a large amount of arsenic on it. One that appears to have a fairly large amount of arsenic on it may test lower than one that does not appear so. We tried to pick those that seemed to have the largest amount of arsenic.

MR. P. M. GILMER: In checking over government apples analyzed by government chemists, we found that in apples collected by the same man in the same orchard, and as carefully sampled, and two or more apples sampled by chance, there were differences in the arsenical content

on government analyses of from about one-fourth British tolerance to about four times British tolerance. It seems from these results that deductions drawn from analyses of sample apples can be of no general value.

MR. ALBERT HARTZELL: I know there is a tremendous variation in the samples. We had samples ranging all the way from two-thousandths of a milligram up to almost eight-tenths, and we attempted to plot it on a frequency curve, but apparently it does not follow the ordinary frequency curve.

MR. E. R. VAN LEEUWEN: We took two samples of apples and picked out the worst we could find. We did that because we have done some work with the Food Inspection Division and they followed that method.

MR. ALBERT HARTZELL: Do you think that is superior to this?

MR. E. R. VAN LEEUWEN: I couldn't say at the present time.

FIRST VICE-PRESIDENT C. J. DRAKE: The next is a paper by D. F. Barnes and S. F. Potts. Mr. Barnes will read the paper.

AIRPLANE DUSTING EXPERIMENT FOR GIPSY MOTH CONTROL

By D. F. BARNES and S. F. POTTS, *U. S. Bureau of Entomology, Melrose Highlands, Mass.*

ABSTRACT

This paper discusses the infestation treated, the control secured, the poison distribution, and the relation of topographical and meteorological factors to the results secured.

In the season of 1926 a satisfactory experiment in the use of an airplane for dusting forest areas was conducted by the Bureau of Entomology. The problem presented was to apply sufficient arsenate of lead to kill the gipsy moth larvae feeding on the foliage. This implied uniform distribution over the treated areas.

The use of aircraft to apply insecticides was first undertaken in 1921 by the Ohio Experiment Station. In 1922 the Bureau of Entomology initiated two separate series of experiments in this work; one at the Delta Laboratory, Tallulah, La., and the other at the Gipsy Moth Laboratory, Melrose Highlands, Mass. The experiments at the Gipsy Moth Laboratory were not conclusive for the first two years. In order to cover forest foliage with a killing dose, large quantities of poison must be used, for which no satisfactory distributing apparatus was available. In addition, the infestation reached a low level in 1924, so that the project was held in abeyance.

In 1926 the project was resumed, and in the towns of Barnstable,

Falmouth and Sandwich, Mass. six plots of 25 acres each, with suitable checks, were laid out. These plots were located from 2 to 15 miles from a landing field at Sandwich. They were selected to give as great variation as possible in terrain and tree growth. A small two-room building at the field served for storage of supplies and as a temporary field laboratory. The laboratory was equipped with apparatus for testing the quantity of arsenate of lead on samples of foliage and with a self recording anemometer, thermograph, and hygrometer for securing weather data. However, no provision was made for obtaining rainfall records at the field as the precipitation records of the co-operative U. S. Weather Bureau observer at Hyannis, about 10 miles away, were available. Observations on the field conditions and results at the plots were facilitated by the use of a quadrat system with points of observation at 200 foot intervals. The system is illustrated in the sketch-plan of Plot 1, Sandwich. The intersection of any two lines established a point for observation. The tree nearest the intersection was used as a center tree for the point, and marked with a three inch band of white paint, together with the letter and number of the intersecting lines, e. g., G-4.

The Sandwich 1 plot may be taken as typical, since it represents the average Cape Cod conditions in regard to topography, weather, and type of growth. It contained 66 acres, 25 treated and 41 untreated, with 91 observation points, 24 in the treated section and 67 in the check. The accompanying sketch shows the relationship of the treated and untreated portions, and indicates by contour lines that the plot was high at both ends, with a valley of three or four acres near the center. The growth, mostly white and scarlet oak, with occasional pitch pines, varied from 10 to 30 feet in height; the canopy was medium to dense. A count of egg clusters, made at each observation point, gave an average of about 13,000 per acre. A sample egg collection showed about 25 per cent parasitism and 60 per cent hatch. Larval and pupal collections made throughout the season showed a small amount of parasitism. Observations made at the height of feeding showed that in spite of egg and larval parasitism there were enough larvae in the plot to completely defoliate it if no treatment had been given.

The first application was made on June 11 between 6:30 and 8:30 p. m., eastern daylight time. At this time about 55 per cent of the larvae were in the third stage, 40 in the second and 5 in the fourth stage. The plane made three trips to distribute the 1000 pounds of dust necessary to treat the plot at the rate of 40 pounds per acre, taking 82 minutes in the air to complete the work. On account of mechanical difficulties with the hopper the number of swaths to deliver one load varied from

8 to 18. The plane flew from 10 to 30 feet above the tree tops, averaging 15 feet, the lower altitudes giving better results. During the dusting a northwest wind blew diagonally across the lot at an average of 3 miles per hour and the relative humidity rose from 43 to 53 per cent while the temperature dropped from 73° to 65° F. The condition produced by rising humidity and falling temperature decreases the upward movement of air, thus allowing the dust cloud to settle. These satisfactory conditions for dusting caused the greater part of the dust to settle into and through the tree tops covering the foliage well. However, in spite of these conditions it was estimated that about 20 per cent of the poison settled outside of the treated area. In an individual tree the distribution of poison was uniform from the top to the bottom; but observations and poison tests showed that the higher and more level parts of the plot received more poison than the deep depressions. On June 14 three days after dusting, 1.15 inches of rain fell, washing about 75 per cent of the poison from the foliage. Because of this it seemed best to re-dust the plot, which was done on the evening of June 19, when two loads, of 500 pounds each, were applied. This took 65 minutes in the air. Good coverage was secured, as the atmospheric conditions were practically the same as at the time of the first application, except for a change in the direction of the wind, during dusting, when it shifted from northwest to south.

Previous to June 14 there was little or no dew, and the wind reached a maximum of 12 miles per hour. These conditions permitted a maximum loss of poison, for it was found that if the dust became wet upon the foliage as a result of fog or dew and was then allowed to dry, it adhered better than when the foliage was dry between the dusting and first rain. The following table compiled from four plots illustrates this fact.

Inches of rainfall	Per cent poison lost	Condition of foliage, dusting to first rain	Number of rains between dusting and sampling	Plot
0.77	74	dry	1	Sandwich 1
0.77	52	wet	2	Sandwich 2
1.15	75	dry	1	Sandwich 1
1.59[1]	46	wet	5	Barnstable 2
1.75	68	wet	4	Barnstable 3
2.26	87	dry	5	Sandwich 1
2.29	79	wet	6	Sandwich 2

[1]0.24 inch of rain fell before the first sample was taken.

From certain of the observation points in Plot 1, Sandwich, leaf samples were taken and the amount of arsenate of lead determined.

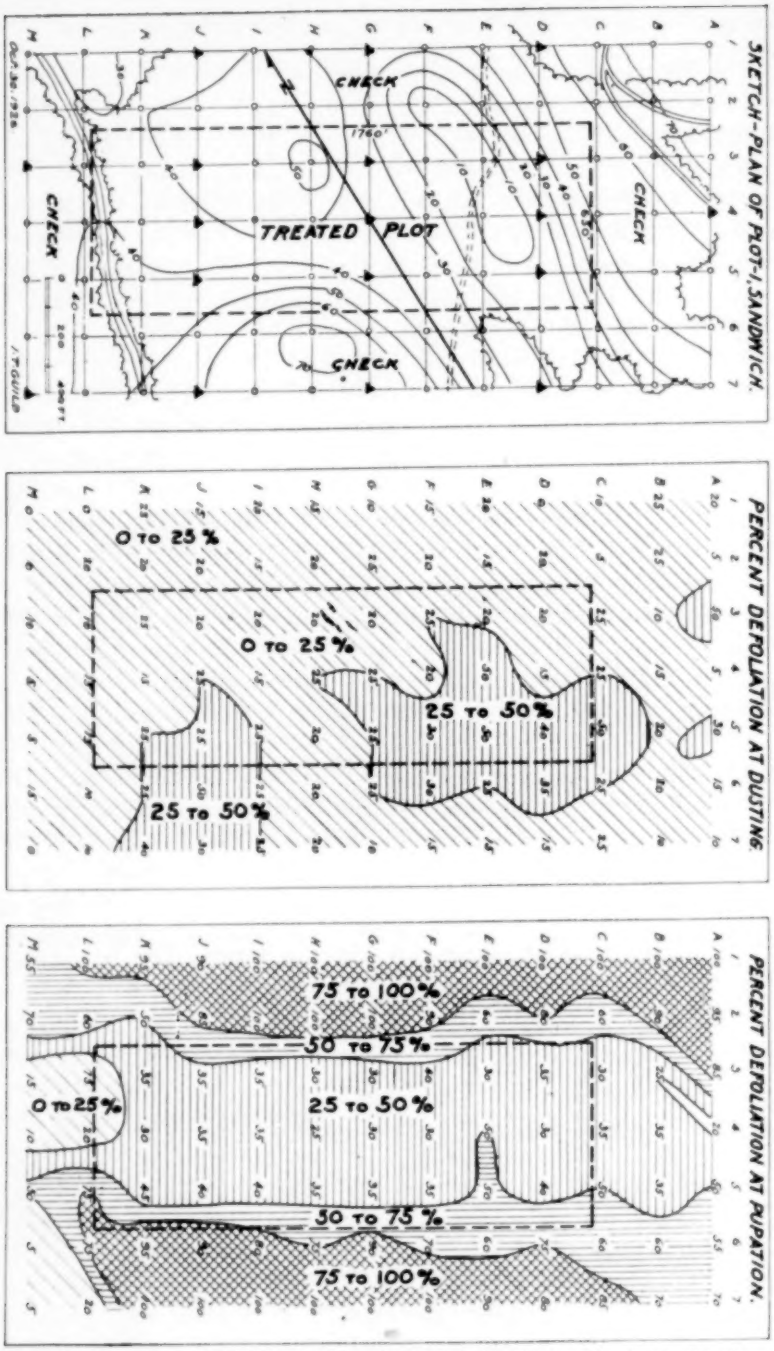

Fig. 10.—Sketch plan and defoliation record for Plot 1 Sandwich, Mass. The sketch plan shows the location of points for observation and collection, the relation of the treated section to the check section, and the topography of the plot. The defoliation diagrams show the percentage of defoliation at each observation point at the times of dusting and pupation. These percentages are grouped, by shading, into four general classes.

Heavy triangles on the sketch plan show the location of these points. These tests showed that the distribution throughout the plot varied and that the first rain removed proportionately more dust than succeeding rains. The following table shows the distribution of the poison in the plot and the loss under the influence of rain.

PLOT 1, SANDWICH. DISTRIBUTION OF ARSENATE OF LEAD IN MILLIGRAMS PER 10 SQUARE INCHES OF LEAF SURFACE BEFORE AND AFTER VARIOUS AMOUNTS OF RAIN, FROM JUNE 11TH TO JULY 15TH

Point	Species	First application		Second application		
		1st test	2nd test	1st test	2nd test	3rd test
TREATED SECTION						
D-3	White oak	1.224	0.250	1.430	0.160	0.088
D-4	Scarlet oak	1.119	0.250	1.440	0.286	0.127
D-5	White oak	0.816	0.157	1.100	0.260	0.203
G-3	Scarlet oak	0.122	0.050	1.070	0.426	0.170
G-4	White oak	0.833	0.333	0.865	0.323	0.159
G-5	White oak	0.741	0.303	0.602	0.171	0.092
J-3	Scarlet oak	2.125	0.500	1.760	0.432	0.197
J-4	Scarlet oak	2.060	0.625	1.270	0.328	0.170
J-5	Scarlet oak	1.500	0.278	1.710	0.472	0.231
Average		1.171	0.305	1.250	0.318	0.160
CHECK SECTION						
A-3	Scarlet oak	——	——	0.240	——	——
A-4	White oak	0.000	0.000	0.800	0.285	trace
D-1	White oak	0.000	0.000	0.200	0.083	trace
D-7	White oak	0.204	trace	0.278	trace	trace
G-1	Scarlet oak	0.000	0.000	——	——	——
G-7	White oak	0.116	trace	——	——	——
J-1	Scarlet oak	0.000	0.000	0.246	trace	trace
J-7	White oak	0.000	0.000	0.328	trace	trace
M-3	Scarlet oak	0.800	0.204	0.652	0.312	trace
M-7	Scarlet oak	0.000	0.000	0.086	0.000	0.000
Average		0.124	0.023	0.354	0.097	0.000
Precipitation		0.00″	1.15″	0.00″	0.77″	2.26″

Note—Check points on each side are 275 feet from treated plot, and those on east and west end are 420 feet and 220 feet respectively.

Observations three days after the first application showed that most of the larvae of the second stage, and many of the third stage, were dead, while the mortality in the larger stages was small. Five days later, at the time of the second treatment, there was about an 85 per cent kill in the plot, which was increased to over 95 per cent before pupation. This treatment increased the kill somewhat within the plot and destroyed many migratory larvae entering the plot from heavily defoliated checks.

The differences between the defoliation of the treated and that of the untreated sections were used as an index of the effectiveness of the treatment. The final observations on defoliation showed a marked decrease from the check toward the center of the plot as indicated in the defoliation diagram and the following table.

	Treated plot	Check plot
Average per cent of defoliation at the time of dusting...	25	18
Average per cent of defoliation at the time of pupation.	36	71
Per cent increase.....	11	53

These observations show that there was an increase of only 11 per cent in the treated area as against 53 in the check, which indicates a satisfactory result when the severity of the infestation is considered.

Methods and Results

The topography of the areas selected for treatment included both flat and rolling sites characteristic of the Cape Cod region. The sketch plan of Plot 1, Sandwich, suggests the type most common, which has neither the flatness of the plains nor the ruggedness of the mountains. However, the region is subject to high winds and local fogs which seriously hindered operations. The type of tree growth on five of the treated plots was similar, with white, scarlet and black oak predominating, although in two plots there were scattering pitch pines. On the sixth plot the growth was oak sprout. The following table summarizes the characteristics of the areas:

General Characteristics of the Dusted Plots

Plot	Growth		Number acres in		Topography	
	Type	Average height	Treated plot	Check plot	Range in elevation	Character
Barnstable 1	oak & pine	20 ft.	25	35	50 ft.	hillside
Barnstable 2	oak	25 ft.	25	6	30 ft.	level
Barnstable 3	oak sprout	6 ft.	20	9	15 ft.	level
Falmouth 1	oak	35 ft.	25	25	100 ft.	hillside
Sandwich 1	oak	25 ft.	25	41	60 ft.	rolling
Sandwich 2	oak	25 ft.	25	41	75 ft.	hillside

These plots were selected in the spring after a survey of the heavily infested areas on Cape Cod. At that time sample collections of egg clusters were made to obtain records of hatching and egg parasitism. These records are summarized below.

Egg Parasitism and Hatching Records for Dusted Plots

Town	Number of clusters	Number of eggs	Per cent of parasitism	Per cent of non-hatch	Per cent of hatch
Barnstable	20	6250	32.9	29.6	37.5
Falmouth	10	5000	23.5	12.0	64.5
Sandwich	10	3200	24.5	16.2	59.3

These plots, treated and check areas combined, varied in size from 30 to 65 acres. Some uniform and time-saving method was necessary for obtaining data throughout such a large area. This was accomplished by means of the quadrat system, mentioned before, which distributed points of observation at uniform intervals of 200 feet. Observations on the degree of infestation, defoliation and poison distribution, were made at these points, so that a series of notes was established for each, from which the conditions for the whole area were determined.

The degree of infestation was determined by an egg cluster count at each point in an area 10 feet square, or 1/435 of an acre. The individual counts, which varied from 0 to over 300, were averaged. From these averages the average number of egg clusters per acre was figured. The following table shows the character of the infestation.

CHARACTER OF INFESTATION IN DUSTED PLOTS AS INDICATED BY COMPOSITE EGG CLUSTER COUNTS

Plot	Degree of infestation	Number of egg clusters per acre		Number of observation points	
		Check plot	Treated plot	Check plot	Treated plot
Barnstable 1	Heavy	9000	17000	51	27
Barnstable 2	Heavy	20000	17000	6	33
Barnstable 3	Light	no egg cluster count made		5	10
Falmouth 1	Heavy	7000	9000	27	25
Sandwich 1	Heavy	13000	13000	67	24
Sandwich 2	Heavy	no egg cluster count made		8	9

Three dosages of arsenate of lead were used in this work: 30, 40 and 50 pounds per acre. The dosage does not indicate the actual amount deposited upon an acre but means that the pilot was given enough poison to cover the plot at that rate per acre if it were evenly distributed within the confines of the plot. Actually, the plots received less than that amount, as there was more or less driftage of the poison as it fell. The Barnstable 2 plot was treated at the rate of 30 pounds per acre, the Sandwich 2 at the rate of 50 pounds, and all others at the rate of 40 pounds per acre. The Barnstable 2 and Sandwich 1 plots were re-dusted after rain had removed part of the poison.

In each plot the distribution of poison was tested by taking leaf samples from certain points as in the Sandwich 1 plot. At each collection point a tree was selected from which all samples in the series were taken. A sample consisted of six leaves, two taken at the top, two from the center, and two from the bottom of the tree, with a total surface of about 75 square inches. The first set was taken as soon as possible after dusting and other samples were taken at intervals after rain. The quantity of

poison was determined by the Hamilton-Smith[1] colormetric method. The results of these tests indicate that distribution is greatly influenced by topographical and meteorological factors. The rolling Sandwich 1 plot dusted under satisfactory meteorological conditions showed more poison in the tests than the hillside plots with an equal or greater dosage of poison. In certain plots it was found impossible to treat steep hillsides except when the wind movement was toward them. The results on the level plots were not conclusive, as the samples on Barnstable 2 plot were not taken until 0.24 inch of rain had fallen, and mechanical trouble with the hopper caused a serious loss of poison in Barnstable 3. The results of the tests immediately after dusting are summarized in the following table.

AVERAGE DISTRIBUTION OF ARSENATE OF LEAD FOR ALL PLOTS IN MILLIGRAMS PER 10 SQUARE INCHES OF LEAF SURFACE IMMEDIATELY AFTER DUSTING

Plot	Application	Number of pounds per acre	Average number mg. poison per 10 sq. ins.
Barnstable 1	1st	40	0.962
Barnstable 2	2nd	30	0.545[1]
Barnstable 3	1st	40	0.466[2]
Falmouth 1	1st	40	0.719
Sandwich 1	1st	40	1.171
Sandwich 1	2nd	40	1.252
Sandwich 2	1st	50	0.991

[1]0.24 inch of rain fell before the sample was taken.

[2]Considerable loss of poison by poor hopper action.

As the work progressed it became apparent that about 1 milligram of arsenate of lead per 10 square inches of leaf surface was needed for quick killing. The Sandwich 2 plot may be used as an illustration. This hillside plot sloped to the south and to the east. Difficulty was experienced in covering it in a uniform manner. The deposit averaged 0.69 milligrams per 10 square inches of leaf surface at the east end, and 1.49 milligrams at the west end. Throughout the plot the kill was practically complete, but it proceeded more slowly where the poison deposit was light. At the east end the defoliation, therefore, increased from 40 to 90 per cent and from 15 to 30 per cent at the west end, a difference of 50 per cent in the first case as against 15 per cent in the second.

All plots except Barnstable 3 showed more or less defoliation at the time of dusting. Since the larvae must eat enough poisoned foliage to

[1]A Colormetric method for showing the distribution and quantity of lead arsenate upon sprayed and dusted surfaces. Hamilton, C. C., and Smith, C. M. Jour. Econ. Ent., Vol. 18 No. 3, pp. 502–509. 1925

receive a toxic dose, there was an increase in defoliation in all treated plots. This increase was greatest in Barnstable 2 where the lowest dosage was used. It was checked against the increase in the untreated areas as an index of the effectiveness of the treatment. To secure the necessary data a record was made at each observation point in the plots immediately after dusting, giving the average per cent of defoliation for a circle 200 feet in diameter immediately surrounding the point. This procedure practically resulted in a record of defoliation for the total plot, and from these figures the average defoliation was established. A similar set of notes was made at the time of pupation. In every case there was a material increase in the per cent of defoliation in the check over that in the treated section, the difference varying from 9 to 42 per cent, as is shown in the defoliation table. The Falmouth plot showed the least difference; it had serious defoliation, as the larvae had reached the fourth and fifth stage before treatment. The greatest differences were found in the plots that were dusted when the larvae were smaller.

AVERAGE DEFOLIATION CONDITIONS FOR ALL PLOTS

Plot	Average percentage of defoliation at time of dusting		Average percentage of defoliation at pupation		Increase in percentage		Increase in percentage check over treated
	Treated plot	Check plot	Treated plot	Check plot	Treated plot	Check plot	
Barnstable 1	26	15	33	33	7	18	11
Barnstable 2	20	23	55	100	35	77	42
Barnstable 3	0	10	10	60	10	50	40
Falmouth 1	43	49	61	76	18	27	9
Sandwich 1	25	18	36	71	11	53	42
Sandwich 2	37	40	50	92	13	52	39

The airplane service for the experiment was supplied by the Curtiss Flying Service, Inc., of Garden City, Long Island, which furnished a Standard J-1 plane, powered by a Curtiss C-6, 180 H. P. motor, and equipped with a pneumatic duster. Mr. John Andrews operated the plane and his hearty cooperation did much to make the experiment a success.

COST

The total cost for the season for the six different plots, two of which were redusted, varied from a minimum of $15.03 per acre to a maximum of $29.12 per acre. This variation was to be expected from the nature of the experiment, for it was sought to test the method of applying poison to plots of differing character and under a diversity of conditions. To test the effect of the poison different dosages were used, and the

cost of the poison varied accordingly. The distribution of the plots at different distances from the landing field, resulted in a considerable difference in flying cost. The adjustment of mechanical difficulties and the adaptation of method to terrain and meteorological conditions had to be worked out as occasion arose which necessarily consumed time and added to the expense. Furthermore, the redusting done in two of the plots, on account of rain, practically doubled the cost in these cases. The fully equipped plane, with pilot and mechanic, was provided at a fixed price per flying hour; the poison was supplied at a uniform price. The cost of a single application, varied from $12.13 to $24.35 per acre, or the average cost being about $15.50 per acre.

Summary and Conclusion

1. In 1926 satisfactory experiments in the use of airplanes for dusting forest areas were conducted in New England. Six plots were treated, five of which were heavily infested by the gipsy moth. In all cases the treated plots showed much less defoliation than the untreated checks, the greatest differences being found in the case of plots dusted when the larvae were small.

2. The flying conditions in treating forest areas are more difficult than in dusting low-growing crops because the trees are of varying heights. As the pilot is unable always to fly close to the tree tops it is necessary to drift the dust cloud into the trees. To accomplish this the dusting must be done when the wind has a low velocity—5 miles per hour or less—and the air has a high or strongly rising relative humidity. These conditions most frequently occur late in the afternoon.

3. It is difficult to treat hillsides unless the wind movement is toward the slope.

4. About 1 milligram of arsenate of lead per 10 square inches of leaf surface is necessary to kill the gipsy moth larvae quickly under ordinary field conditions. About 40 pounds of poison per acre is necessary to secure this rate of distribution.

5. Airplane dusting is best adapted for the treatment of large forest areas and its results for the season of 1926 encourage the hope that this method can be adapted for insect control in such territory.

Mr. J. S. Houser: I want to ask if Mr. Barnes thinks that this work would be applicable to woodlands in general in New England?

Mr. D. F. Barnes: On account of the cost I think it would be applicable only in special instances. For instance, a lumber company holding large acreage might treat a portion of their timber which was infested by a defoliating insect in order to protect the balance of their holdings.

Adjournment: 4:30 p. m.

REPORT OF THE SUBCOMMITTEE ON INSECTICIDE MACHINERY

In the following report it has been attempted to give material illustrating the trend of thought of workers with insecticide machinery, and suggestive of new activities, rather than the compilation of detailed data. We believe that the list of research projects involving this subject will be of value, and we trust that workers will inform us of new projects as they are undertaken or old projects which may have been omitted, in order that the list may be complete.

Dr. Philip Garman has been especially responsible for the work in the North East; Mr. J. A. Berly, in the Cotton States; Mr. B. B. Fulton in the Middle West; and Professor E. R. deOng in the far West. We are indebted to workers quoted in this report and to many others throughout the country for their response to our requests for information.

1. Location of Research Projects on Insecticide Machinery

Michigan Agricultural Experiment Station. A comparative test of orchard sprayers; large and small outfits under high and low pressures.

Ohio Agricultural Experiment Station. A study of hand sprayers and dusters for truck crops.

Purdue University. A study of spray nozzles to determine proper load for each type. Under direction of Professor O. G. Anderson.

United States Bureau of Entomology. A study of cotton dusting machinery—B. R. Coad. Insecticide machinery in connection with truck crop insect control.—R. E. Campbell. Insect collecting machines—J. E. Dudley.

U. S. Bureau of Entomology and the California State Department of Agriculture, Cooperating. Developing a hot water sterilizer for bulbs. Work conducted by Mr. C. L. Doucette of the Bureau and Messrs. Mackie and Scott of the State Department of Agriculture.

University of California. A cooperative project on the study of stationary spraying plants. Publication being prepared.—W. P. Duruz and B. D. Moses.

An investigation of methods for standardizing commerical power sprayers, and on the "economics" of spraying.—E. R. de Ong.

Santa Paula Citrus Fruit Association, Santa Paula, California, Analyses of nicotine dust with Bean self-mixing duster to determine effectiveness.—C. T. Dodds.

2. Self-Mixing Duster

Reports were received from California, Florida, Georgia, Illinois, Maryland, Massachusetts, Michigan, New Jersey, New York (Long Island and Hudson Valley), Ohio, Pennsylvania, Wisconsin. All reports dealt with the Bean machine.

The comment was generally favorable, although there is unanimous opinion that the machine needs improvement. Several workers call attention to the heat generated in the mixing process, which may aid in the incorporation of the nicotine, but may prove dangerous in some cases.

One common difficulty lies in the fact that mi ing is not effective if much more than 50 pounds of material is placed in the hopper at one time. One worker calls attention to the fact that a 4 h. p. engine is not powerful enough to run the machine effectively, and some difficulty was experienced even with an 8 h. p. engine. Considerable difficulty was experienced with the feed. When there was a large amount of dust in the hopper, the flow of dust was too great; when the hopper was less than half full, the flow of dust was insufficient. This is especially troublesome when dust is applied

under a hood or in other places where the discharge can not be closely watched. The cut-off needs improvement.

With regard to materials mixed, Mr. J. E. Dudley, Jr., of the U. S. Bureau of Entomology, stationed at Madison, Wis., wrote as follows: "With two experimental carriers of nicotine and calcium cyanide, it was found impossible to mix them in this machine. One, silversand, a volcanic dust found in unlimited quantities in Utah and used commercially by some concerns, was found to be so heavy and packed so hard that the engine would not turn the mixing paddle. At the other extreme, Celite, an extremely light, filtering compound sold by the Celite Products Company of New York City, could not be mixed for it stayed right on top like a foam, even when 50 per cent lime was used. This Celite weighs approximately 35 pounds to the bushel. These were the two extremes and between these I found that the speed and efficiency of mixing varied somewhat if quite light or quite heavy carriers were used. Apparently the machine was made primarily for calcium hydroxide. Gypsum is a least bit heavy for it while some of the lighter colloidal substances are a little light for it."

Mr. C. T. Dodds, Entomologist of the Santa Paula Citrus Fruit Association, Santa Paula, Calif., writes as follows regarding the uniformity of mixture of dust in the self-mixing machine: "The following tests were made: 50 pounds of dehydrated lime was placed in the hopper and the machine was started; nicotine sulphate was added to make a 2.60% dust. At the end of five minutes four samples were taken from the hopper. They analyzed as follows: center at surface 2.63%, surface at side, 2.81%, center near middle, 2.79%, middle near side 2.74%. This gave an average of 2.69% with the greatest difference 0.18%. The machine was then run half an hour and then the samples were analyzed which were 2.67%. For comparison two drums of ready-mixed dust had samples taken near the surface and from the middle of the drum. The analyses were as follows:

Top	2.76%	2.51%
Center	2.69%	2.71%
Average	2.72%	2.61%
Difference	.07%	.20%

3. Economics of Spraying Operations

There is much interest in the economics of spraying, especially with regards to rapidity of spraying vs. thoroughness and economy of operations. There is a regrettable lack of accurate data in this connection, and the following discussion indicates that a thorough scientific study of the problem might result in great savings for the large orchardists of the country.

Mr. R. S. Woglum, Entomologist for the California Fruit Growers Association, Los Angeles, writes: "We have during the past two years, kept a close observation on the spray work of some forty to seventy-five spray machines, almost exclusively machines of the super-giant type as Hardy, Bean, Friend and Demming.

"It has been our experience that there is no place for a spray machine in the citrus industry except one of these large types which is capable of maintaining a pressure of 350 to 400 pounds when three spray guns are being used. All of these machines are capable of maintaining this pressure. This super-giant machine is the only economic type to be used. At the present time even it is not entirely powerful enough for California citrus spraying. The spray nozzle has no place in the citrus field. The only operator to use a machine with nozzles and perhaps do it economically is a

grower with a very few acres and lots of time on his hands. The economics of citrus spraying is not one of determining how little material one can use on a tree by reducing the size of the aperture or using a mist spray. Labor and time are more important than material.

"Our commercial operations are run largely on the basis of a cent or one and one-fourth cents per gallon for material applied. This practice is so deeply set in California that I am convinced it can not be readily changed. This method is giving the grower satisfaction where spray operators are careful, conscientious men and it, furthermore, is more or less satistactory to the spray operators. Our conditions at present demand the use of twelve to twenty 300 gallon tanks a day in order to cover the acreage that has to be covered and do it within the limited time. Right at the present time the complaint on all sides is that the work is progressing too slowly,—not enough acreage is being covered within the time it should be covered. Mist nozzles would slacken the speed very materially; in fact, a commercial operator using these nozzles would go bankrupt within a very short time in competition with the gun. It is not a question that a spray nozzle can not cover a tree as thoroughly as a spray gun, but the question is that the spray nozzle can not cover a tree as thoroughly and do it within as short a time. There is an overhead of around $15.00 per day for labor exclusive of team hire on a spray rig. The saving of a certain amount of spray material is unable to offset the labor costs under our conditions. There is a natural tendency of growers to invest just as little money as possible in equipment, and the mist nozzle would require far more investment than the spray gun because of the larger number of machines required to cover a certain acreage. There is, furthermore, the difficulty ever present in California of securing an adequate supply of good labor. With the type of labor available our observation has been that poorer coverage is general where mist nozzles have been used than with the gun."

The viewpoint taken above is probably typical of many of the large scale orchardists of the west. That this race for speed and economy by increasing the spray output may be carried too far is suggested by the following from Professor deOng, University of California: "Another point . . . is the economics of high discharge rates versus high priced labor. In other words, if we believe our nozzle men are to be paid double what they were five years ago, what effect is that going to have on the discharge rate at which the machine may be operated so as not to lose, by increasing the rate of discharge of spray to compensate for increased cost of labor.

"To cite an example, one outfit I tested was wasting between twenty and forty cents per tree of spray material, and saving one-half cent on the time of the operator."

In eastern fruit sections, where operations are usually not on such a large scale there is much less tendency toward excessive rates of discharge; in fact, there is a swing back in favor of the spray rod in some sections. Even in eastern sections, however, there is a definite problem regarding rapidity vs. effectiveness and economy.

4. Standardization of Spray Machinery

It was practically unanimously agreed in the returns from questionnaires sent out that it would be very desirable to standardize spray equipment as much as possible. Considerable doubt was expressed as to the feasibility of bringing about such standards except by a gradual process of evolution.

So far as we have determined, the only definite attempt at standardization of the operation of spray outfits has been done in California.

Professor E. R. deOng writes as follows: "I am at present carrying on work with

the horticultural officers in southern California in an attempt to gather field data on all phases of the operation of spray machines, that is, power outfits. The horticultural officers are charged with the duty of regulating all of what we term 'commercial' sprayers, or those who are applying spray for a definite charge per acre or per gallon. The question has now arisen as to what points are best for an inspector to observe and pass judgment upon as to whether or not the outfit may be performing satisfactorily both to the grower and the operator.

"The equipment that we are suggesting for the inspector is: (A) A 'T' to attach to the end of the hose, one end of which receives the gun or rod and the other is for testing the pressure gauge and then with all leads running, the readings on the gauge at nozzle and at pump are compared and if more than 25 pounds variation is shown, it is considered that the machine is doing unsatisfactory work. Three things are commonly recognized as causing a drop in pressure: First, the use of pipe or hose of too small a diameter. This can be obviated by using larger sizes, for example, changing from one-half inch to three-quarters. Second, too large an aperture in the disc; this, of course, must be considered with the type of spray desired, whether coarse or fine. Third, pump not giving sufficient pressure. The latter two difficulties can be overcome largely by either running the pump at a higher pressure or using smaller apertures. (B) Pressure gauge as mentioned above, and for this kind of work tested gauges should be used which can be bought from the following companies: American Schaeffer and Budenberg Corporation, Berry and South Fifth Streets, New York City, Foxboro Company, Inc., Foxboro, Massachusetts, Ashcroft Manufacturing Company, 100 East 42nd Street, New York City. (C) A graduated measure of five or ten gallons capacity for determining discharge rate.

"Spray manufacturers with whom I have talked consider that these points properly checked will give a very good idea of the behavior of outfits."

5. Stationary Spray Outfits

The stationary spray outfit has come into use to a larger extent in California than in the eastern fruit sections. Studies that are being conducted on this outfit may show that it has a larger field of application than it has filled heretofore. Professor W. P. Duruz of the University of California writes an interesting discussion of the stationary spray outfit:

"Professor B. D. Moses and myself are working on a cooperative project dealing with an investigation of the stationary spray plant. We have been making numerous trips throughout the State, visiting some ten or more plants that are now in operation and we have run a great many tests while spraying was going on, with the view of determining the efficiency of the plant, pressure drops, power factors, cost of operation and upkeep, and special advantages and disadvantages of the system. The original stationary plant was installed in the Hayward Reed orchard in 1908 and at the present time serves 212 acres of full bearing trees and is still giving satisfactory operation. There are other plants that have been installed since that time and all of the users are uniformly agreed that this system of spraying is economically sound where adverse soil conditions prevent spraying at the critical time, and when at least three sprays a year are necessary. The acreage covered by these plants varies from 19 to 260 and the cost of installation ranges between $35.00 and $57.00 per acre. The cost of spraying, including labor, material, and power, ranges between two and three cents per gallon, depending upon the kind of material and dilution.

"The advantages of stationary spraying systems may be enumerated as follows:

"1. Spraying may be accomplished in spite of adverse soil conditions.

"2. Pests that require quick action are speedily controlled.

"3. Large orchards may be sprayed as effectively as small ones with the same equipment.

"4. There is considerable saving in time and labor. Ninety-five per cent of the time is used in spraying and no time is lost in refilling.

"5. The system is a permanent improvement to the property and there is no great depreciation, at least during the first ten years.

"6. Spraying is possible with minimum danger of knocking or bruising the fruit on low hanging branches.

"7. Props do not interfere with spraying.

"8. Hillside orchards may be more easily sprayed.

"9. Intercropping or permanent cover crops may be employed. Tractors and teams are eliminated.

"10. Great conveniences due to the use of electric power.

"Some of the disadvantages may be stated as follows:

"1. High initial cost. This point, however, is not such a great disadvantage when you consider that the system is in use 15 years and longer.

"2. All responsibility is in one plant. If there is any breakdown all spraying must be stopped. However, this is true of a portable rig also.

"3. Non-portability. Outlying tracts must be sprayed with a portable rig.

"4. Possibility of spray material settling in pipes. This is true particularly where large mains are used and too few hoses used to keep up sufficient velocity to prevent settling. This is overcome by using a brand of arsenate of lead that maintains its suspension, also by using pipes of not too great diameter and operating enough hoses to keep liquid flowing.

"5. Upkeep and attention to numerous parts.

"6. Possible damage to system during cultivation.

"7. Possible corrosion of pipes by spray material. From actual practice, however, this does not seem to be an important objection because we have examined the interior of pipes which have been in use for 15 years or longer and are unable to find any evidence of corrosion.

"8. Possible loss of spray material by leakage. This, too, is a small point and owners do not find this a serious disadvantage.

"9. Some spray material may be wasted during the flushing out of the lines. This objection is also overcome by a careful man who supervises the running of the plant. With a little practice the engineer is able to judge the amount of material needed to spray, and adjust the supply so that clear water is turned into the line just before quitting time and the sprayer knows it is time to stop when clear water reaches the nozzle.

"10. There is some loss in pressure due to friction. This varies from 25 to 50 pounds, but the pumps are easily adjusted to high pressure and on account of the stability of the pump there is greater assurance of maintaining high pressure at the pump.

"11. Demand charge on electric motor is constant. Some growers overcome this by using their motor for other purposes such as cutting silage, sawing wood, etc.

"12. Freezing and breaking of pipe. This is a disadvantage in colder regions where the ground freezes, but is overcome by laying the pipe to an even grade and providing for proper drainage of the lines before winter."

6. New Developments

A new type of sprayer has been developed and is being tested experimentally. This machine has been termed the "liquid duster" because of the fact that it applies a liquid spray or mist in the same manner as dust is ordinarily blown onto the foliage. One such machine, manufactured by the Rex Spray Company, Toledo, Ohio, has been in use in Connecticut during the past season. Regarding it, Dr. Garman writes:

"The machine consists of a duster and sprayer combined, the duster consisting of a high-speed fan similar to that of many dusting outfits. The spray is delivered by a nozzle in the end of a short delivery tube, and the liquid is blown by the force of the air upon the tree. The engine driving this apparatus is a standard Ford engine, at least in the one seen this year, on the outfit. The liquid pump tank and blower do not occupy more space than that occupied by a standard spray outfit.

"Advantages lie in the rapidity of application, which is about the same as a dusting machine, except for time required to fill the tank. It is also much easier to apply liquid by this means than by the usual gun or rod.

"Disadvantages apparent (judging from the opinion of grower using it) lie in difficulty in reaching high trees in windy weather. There are also some mechanical difficulties, one of which appears to be the high speed fan, which, unless extremely well made, is likely to give trouble.

"However, the machine seems to be a promising invention and deserves the attention of horticulturists, entomologists, and fruit growers generally. Whether it will prove practical can only be learned by trial, but from present appearances it seems to be good."

In Wisconsin Mr. J. E. Dudley, of the U. S. Bureau of Entomology, has made such radical improvements in a collecting machine which he terms the "aphidozer," that even this old, familiar apparatus may truly be termed a new development. Mr. Dudley writes as follows:

"The aphidozer was designed and developed at the Madison, Wisconsin field station of the Federal Bureau of Entomology in an effort to solve the Pea Aphis Project after other remedies had apparently failed in this section. The machine consists of a hopper 7 ft. long by 2 ft. high by 17 in. wide, suspended from a special framework mounted on two wheels. At the forward opening of the hopper is a reel consisting of seven specially made brushes for brushing and knocking the insects from the plants into the hopper. A special feature of the machine is a series of four transverse iron rods just to the rear of the lower forward edge of the hopper. These have a quadruple function: 1. To sift the insects, thus allowing them to fall through from the plant; 2. To retain them by preventing the plants from again pulling them out of the hopper; 3. To provide a surface over which plants may lie at an obtuse angle while they are being brushed and knocked; and 4. A means for helping to clear the under side of foliage of its insects.

"Although designed primarily against the pea aphis, the machine was soon found to work on other crops with less injury to the crop than to peas. It is now being used in addition to peas, in an experimental way entirely, against miscellaneous insects on alfalfa, against the alfalfa weevil, and against miscellaneous insects on potatoes.

"I feel that it is too early to say anything definite as to the effectiveness of this machine. It appears to be effective against three insects on three different crops, but its effectiveness may be lessened by seasonal conditions affecting both the insects and the crops as the experiments are continued.

"The advantages of the machine are:

"1. The cheapness of application, requiring only the time of a man and one horse to treat fields.

"2. The fact that it can be used in any kind of weather except during rain.

"3. The rapidity with which acreages can be swept, the only stops necessary being to empty the hopper when it contains a bushel or more of insects.

"4. The fact that it requires little skill to use it properly when compared with means of applying insecticides.

"5. Perhaps as important as any, the psychological effect upon the user when unbelievable numbers of insects are actually caught and brought to his attention.

"The disadvantages are:

"1. In that the plants are actually hit in being swept, there is an opportunity for damage, particularly to crops like peas when it is not used at the right time or when the speed of the reel is increased above the safety point.

"2. The fact painfully brought out last summer, that many users expect to find it a panacea and use it without any common sense at all, with the resulting damage to the crops.

"3. The greatest disadvantage at present is the fact that we are not exactly sure of what its effectiveness will be under the conditions of the average season.

"In short, this machine has decided possibilities on certain crops, has already shown considerable effectiveness in increasing yield during the conditions of one season, but showed no increase in yield another season. Although simple to operate, yet it must be used with intelligence, and is still decidedly in the experimental stage."

F. H. LATHROP
PHILIP GARMAN
B. B. FULTON
R. H. SMITH
Committee

REPORT ON OIL EMULSIONS

Dec. 27, 1926.

TO THE COMMITTEE ON POLICY:

Your sub-committee, appointed to summarize and so far as possible standardize oil sprays, begs leave to offer its third annual report as follows:

Questionnaires were again used, this being the only method available to obtain the needed facts. These were sent to entomologists and others in the various states and provinces of the United States and Canada. Replies with data were received from the following, listed alphabetically: A. J. Ackerman, U. S. D. A., Arkansas; J. L. Baskin, Tennessee; California State Department of Agriculture; E. L. Chambers, Wisconsin; Leroy Childs, Oregon; J. J. Davis, Indiana; E. R. de Ong, California; L. L. English, Illinois; B. B. Fulton, Iowa; S. B. Fracker, Wisconsin; Arthur Gibson, Canada Dept. Agr.; T. L. Guyton, Pennsylvania; W. S. Hough, Virginia; R. W. Leiby, North Carolina; G. M. List, Colorado; Z. P. Metcalf, North Carolina; D. C. Mote, Oregon; E. J. Newcomer, U. S. D. A., Washington; New Jersey Agric. Expt. Station; J. R. Parker, Montana; P. J. Parrott, New York; R. H. Pettit, Michigan; B. A. Porter, U. S. D. A., Indiana; H. J. Quayle, California; C. H. Richardson, U. S. D. A.; R. H. Robinson, Oregon,; W. A. Ross, Canada Dept. Agr., Ontario; W. J. Schoene, Virginia; O. I. Snapp, U. S. D. A., Georgia; E. P. Venables, Canada

Dept. Agric., B. C.; R. S. Woglum, California Fruit Growers Exchange; M. A. Yothers, U. S. D. A., Washington; W. W. Yothers, U. S. D. A., Florida.

The excellent cooperation on the part of so many men in different parts of America has enabled us to give conclusions of value and this aid is very greatly appreciated by the committee.

The information gleaned from the answers submitted is summarized as follows:

I. Effect on Insects

1. In areas where the San Jose scale is a pest, the growers continue to use dormant oil sprays and are getting satisfactory results. No changes in recommendations are warranted although the answers show a greater tendency to use 3 per cent strength where oil emulsion is used as the control and seems to be more consistently effective than where 2 per cent oil is used.

2. Reports on the oyster shell scale show the usual variation in results with dormant sprays. In a few cases lime-sulphur gave better results than oil sprays. Fairly good control obtained with both commercial oil sprays and lubricating oil emulsion. In a few cases 3 per cent is said to give good control but in the majority of cases an 8 or 10 per cent oil content was found necessary to secure satisfactory kill. After careful consideration of all answers it would appear that consistent spraying every year with a 3 per cent oil will prevent oyster shell from increasing and that an 8 or 10 per cent spray will give fairly complete control with one thorough application. Dormant oil sprays are satisfactory for the control of the scurfy scale, a 3 per cent oil usually being sufficient.

3. The oil sprays are evidently proving increasingly useful as dormant sprays for insect control. Pettit reports good control of *Physokermes abietis* and *Chermes abietus* with 1–20 commercial and 2 per cent lubricating oil emulsion, when applied shortly before new growth starts in spring. Z. P. Metcalf secured effective control of gloomy and Euonymus scales. Fracker and Chambers report effective control of *Gossyparia spuria* on elm. Snapp found a 3 per cent emulsion would destroy *Lecanium quercifex* and *Ceroplastes cirripediformis*. A 3 per cent emulsion seems generally effective against the adult pear psylla if used just before egg-laying. Not very effective against eggs although one experimenter observed that young psyllids hatching from eggs sprayed with oil spray failed to develop. The oil also seems to be effective against nymphs.

The common red spider and the European red mite are effectively destroyed with 3 and 4 per cent emulsions. Spring applications seem to be preferable.

Ross found 3 per cent emulsion, applied when buds are on point of bursting, as good a control for black cherry aphis as nicotine. Also that 4 per cent emulsion with 2–4–40 Bordeaux before buds swell controls peach leaf curl and cottony peach scale. The brown apricot scale on prunes and apricot is satisfactorily controlled with a 2 per cent concentration of any of the lighter lubricating oils. A 2 to 3 per cent emulsion gives good control of cottony maple scale according to Davis. M. A. Yothers reports on tests against the eggs of three species of treehoppers (*Ceresa bubalus*, *C. basalis* and *Stictocephala inermis*) which insert their eggs in the bark leaving only the outer tips more or less exposed. Early spring dormant applications of 2 per cent lubricating oil emulsion plus ½ per cent cresylic acid gave a 74 per cent kill while the same treatment about six days before eggs began to hatch killed 89 per cent of the eggs. The recommendations for leaf-roller control varies from 4 to 8 per cent oil. In a comprehensive statement read before the last summer meeting of Northwestern

Horticulturists, Plant Pathologists and Entomologists at Tacoma, Parker reviewed the work and recommendations being made by various states for leaf-roller control. He concludes that effective control is obtainable with a 4 per cent spreader emulsion or with an 8 per cent emulsion without spreader. Parker also reports effective control of blister mite with 4 to 8 per cent emulsion. Hawley's experiments (Utah Station Bulletin 197) do not agree with these conclusions. Pettit reports 97 to 100 per cent kill of apple aphids in a series of tests with different commercial oils and oil emulsions when applied as a delayed dormant spray.

4. This question called for a number of answers, all bearing on the efficiency of summer oil sprays for the control of the codling moth. It was generally agreed that a 2 per cent emulsion or oil spray would kill codling moth eggs or those eggs laid on the oil-sprayed surface soon after spraying. The oils seem to have little or no hindering effect on oviposition since the moths seem to lay as freely on oil-sprayed surfaces as elsewhere. The oil covering seems to have little effect on the young larvae unless the spray was recently applied, but answers to this question were quite variable. In some cases the residual effect of the oil lasted over several days to a week but usually only a day or two. Hough made a series of experiments thoroughly spraying individual apples with a commercial oil spray recommended for codling moth control. Twenty-four hours later newly hatched larvae were allowed to crawl on the apples. Twenty per cent died on the apples, some before and some after making a "sting." Thirty-four per cent of the larvae were successful in entering the oil-covered fruits. No answer indicated that codling moth control could be accomplished with oil sprays where arsenicals were omitted even in part. Every one seemed to agree that we do not have data to warrant recommending oils in place of arsenicals and some were very emphatic that oils could not be substituted for arsenicals. Experiments indicated that combinations of oils and arsenicals are better than arsenicals alone. However, a serious difficulty arises when this combination is used or where oils follow arsenical sprays as was brought out especially in statements by E. J. Newcomer. Such combinations make it difficult if not impossible to remove the spray residue, an increasingly important problem.

In answer to the question, "Effect of substitution of oil sprays for arsenicals on abundance of and injury by other chewing insects", Porter states that red-banded leaf-roller was worse in blocks sprayed only with oil than in those sprayed with an arsenical. Flint found *Metachroma interruptum* causing considerable damage to apples where oil alone was used although satisfactorily controlled where arsenate of lead was used.

5. This question called for information on the effectiveness of summer oil sprays for orchard insects. Spring applications of 2 and 3 per cent emulsions gave control of San Jose scale equal to dormant sprays but summer applications were less effective although giving sufficient control to make it useful in cases of severe infestation or infestations likely to cause spotting of fruit. Exposed aphids or leaf-hopper nymphs fairly well controlled with 2 per cent emulsion, the degree of control being quite variable. Apparently not as efficient a protection as nicotine sprays, although in some cases as high as 96 per cent kill of aphids was obtained with a 3 per cent emulsion. In general the 2 per cent emulsion gave complete control of oyster shell scale when applied shortly after hatching. Essig reports good control of mealy bugs, mites, soft scales, young scales and aphids under California conditions, with 2 per cent emulsion. *Pseudococcus* spp. on many plants and *Tetranychus* sp. and *Paratetranychus* sp. on fruit trees are mentioned specifically. *Lecanium corni* on deciduous

trees was controlled with 2 to 4 per cent emulsion. Summer attacks of red spider on deciduous trees are commonly checked with summer sprays of oil emulsion (?2 per cent) according to de Ong, the species concerned including *Tetranychus* spp., *Bryobia praetiosa* and *Paratetranychus pilosus*. Mote, Robinson and Childs in Oregon found 1½ to 3 per cent emulsions effective against two-spotted mites on strawberry, pear, hops and cherry, the strength used apparently dependent on the plant being treated. Faurot's experiments in Missouri, as reported by Haseman, indicate that the summer applications of 1 to 2 per cent oil emulsion have proven quite effective in the control of the grape leafhopper.

6. Summer applications of oil sprays are generally effective controls for many citrus insects. In general we refer to summer spraying as applications made when trees are in foliage. In the case of citrus trees the term summer spraying may be misleading since these trees are evergreen. We may, however, recognize a difference between summer and winter spray applications in the case of citrus plants for it is known that such trees are more liable to oil spray injury during the warmer summer months.

In Florida the oil sprays are generally effective against scale and white fly. According to de Ong the white lubricating oils are being used very extensively in citrus districts of Southern California, especially in the regions where the scale is said to be resistant to fumigation and the most successful procedure at present is spraying with oil, followed within 10 days by fumigation. Essig reports good control of *Coccus hesperidum*, *C. pseudomagnolarium* and *Saissetia oleae* with 2 to 4 per cent emulsion.

7. But few reported results of experiments against insects attacking greenhouse and ornamental plants. There is, however, apparently a good field for work and experiments to date indicate a much greater use of oil sprays for this class of plants than in the past. Essig and de Ong report good control of mealy bugs on ornamentals, Essig mentioning specifically a 2 per cent emulsion as being effective. Parrott found a 2 per cent homemade or commercial white oil emulsion effective against white pine scale and further reports that experiments to date give promise of a more general usefulness of the oil sprays against such pests on evergreens.

It should be borne in mind, however, that the degree of tolerance varies for different species of conifers and some oils are more injurious than others. Moreover the application of oils to such species as Canadian blue spruce destroys, for a considerable period of time, the natural coloration, which is an objectionable feature.

II. Effect on Plants

At present, one of the most important factors limiting the use of oils in the summer time is, according to Porter, "a lack of fundamental knowledge as to its exact effect on plant tissue, the conditions under which injury is most likely to occur, and how much margin of safety there is, if any."

Newcomer writes, "I believe the plant physiologist should be interested in work on oil sprays, particularly those used during the growing season." As our problems become more detailed and intricate we must look to workers in specialized fields for assistance and cooperation. In the case of injury to plants by oil sprays, which involves so many factors, the assistance of the plant physiologist, would no doubt be a great help, for while the entomologist can detect most of the injuries, a plant physiologist would know better what to look for, how to measure injury and could diagnose the injury with greater efficiency. We must know the reasons for insecticide injury

to eliminate the trouble and it is hoped that workers may find it possible to enlist the cooperation of their colleagues in plant physiology.

8a. Dormant applications of oil sprays are generally recognized as safe. No injury reported where properly used. In one case severe damage followed when peach trees were sprayed during a snow storm. It is generally recognized that injury by oil sprays applied during the dormant period is most likely where temperatures are below freezing at the time of spraying. As would be expected citrus trees are more subject to injury in winter than are deciduous trees.

8b. No damage to apple by 2 to 4 per cent emulsions after buds had swollen but several reported some injury with certain commercial oils when used during the delayed dormant period. Delayed dormant sprays are not generally safe for peach.

8c. Harmful effects of summer applications. Spraying of peach trees with any of the oils is generally recognized as unsafe.

Every report indicated some injury to apple by summer applications. These were usually of minor importance and consisted of burning of leaves although in some cases the damage amounted to a considerable commercial loss. In some instances the same observer reports all types of injury from a slight burning of foliage to a discoloring and cracking of the fruit, with no apparent explanation. In general, a 2 per cent emulsion gave no injury or so slight as to be negligible, excepting when applied during very hot weather (90° F. or above). A more general injury results from a 3 per cent emulsion. Some of the commercial oils give a more or less consistent burning, oftentimes severe.

Temperature and humidity are doubtless important factors. According to Quayle, harmful effects to citrus plants from the use of heavy lubricating oils include inhibition of blossoming and fruit sets, effect on the rind of the fruit and effect on shipping and keeping qualities. These types of injury occur in southern California near the coast but do not occur to any extent 50 miles away from the coast. This injury induced by the heavy lubricating oils is due, according to Quayle, to the retention of the oil on the foliage and fruit and consequently the injury is more marked in the cooler and moister sections along the coast and during the winter period rather than in the interior drier sections or during the long summer months. Essig and deOng report that trees suffering from drought are more subject to injury. Woglum says, "weather plays a very important part in oil injury, particularly very hot weather with low humidity."

From the variety of answers received to this question it is very evident that a careful study of all factors influencing injury by oil sprays is much needed.

9. Effect of summer oil sprays on foliage, size, color, and finish of fruits, time of ripening, chemical and physiological changes in fruits, keeping quality, etc.

The answers received to this question again emphasize the need of further study in cooperation with plant physiologists of the exact factors which cause or prevent injury.

The use of a 1 or 2 per cent emulsion on deciduous fruits, excepting peach, under normal favorable conditions, seems to be safe with little or no harmful effects to the foliage, fruit or tree. Dormant applications of 7 or 8 per cent of certain commercial oils resulted in killing or retarding the development of apple buds according to Parrott. English reports retardation of opening of leaf buds of apple by excessive strengths of delayed dormant applications, this being especially true with Grimes varieties. Several referred to the different degrees of susceptibility to injury by different varieties of apple. Porter reports serious injury to the finish of the fruit,

especially if the application is made close to harvest time. He notes that in such cases the skin is dull and lifeless, giving the apple an unattractive appearance. In addition, oil-sprayed apples collect a great deal of dust if the orchard is dusty or near a dusty highway and such dust is very difficult to remove. Childs reports that growth may be checked and fruit fail to properly color.

Evidently the citrus fruits are more subject to the effects of oil sprays than are deciduous fruits. W. W. Yothers reports that the excessive use of oil will prevent the foliage from attaining its natural size and in the case of oranges the skin will remain green longer than where no oil is used. Woglum notes the following harmful effects from the use of oil sprays: retarded coloration of fruit, reduction of blossoming and fruit set, drop of immature fruit, burn of fruit, increase of aphis and mealy bug following heavy oil emulsions, increase of dead wood, influence on the quality of fruit and perhaps on the keeping quality. Quayle finds that in sections near the coast certain oils stimulate the younger growth. On the other hand the older leaves are oftentimes dropped. If applied within a month, or two or three months before harvesting, it delays coloring and also interferes with artificial coloring of fruit.

10. Some of the commercial miscible oils cannot be used on deciduous foliage of any kind with any degree of safety. The emulsions seem safe for apple, pear, plum, prune, raspberry, grape, cherry and citrus. It is not safe to spray the foliage of peach and elm. White oils are apparently safer than the ordinary lubricating oils.

11 and 12. The limiting factors in the use of summer oil sprays include high temperature and humidity, difficulty of coverage of branches, cost of the white oils, and our lack of information regarding the exact factors which cause injury. In combination with or following the use of arsenate of lead it causes the lead to adhere too firmly, offering difficulties as a result of excessive adhering residues. Oil-sprayed fruit was highly polished and where oil and lead were used in combination the residues were less conspicuous according to Flint.

Present information will not permit general recommendations for the use of summer oil sprays. They are however, highly useful for more or less specific situations and apparently will find greater usefulness in the future.

III. Chemical and Other Problems

13. Of those answering the question relative to the oil emulsion formula found most satisfactory and most generally used by growers, eight indicated the boiled oil emulsion with soap as the emulsifier, five the caseinate-oil emulsion, and one the Bordeaux-oil formula. In several cases two or more formulae were indicated without preference. In a number of instances, especially those reporting from the west coast, there is a more general use of the commercial oils. The general tendency seems to be to purchase the spray ready prepared, whether an emulsion or a miscible oil, rather than to use home-mixed, except in the case of some of the larger growers.

14. Are the physical and chemical properties of oils as now determined a true index to the selection of suitable oils for different insecticide purposes?

It seems to be generally agreed that viscosity, volatility and specific gravity are a partial index but not a true or complete index. W. W. Yothers says, "Our experiments with different oils having the same chemical and physical properties have given very contradictory results." The sulfonation value and oxidation are factors which may prove of value. The first three qualities seem to offer fairly reliable criteria to determine the insecticide value. The percentage of unsaturated hydrocarbons present or the sulphonation test seems to indicate the likelihood of injury to

plant tissue. Frank A. Herman, chemist of the Central Experimental Farms at Ottawa, Canada, in a letter to Arthur Gibson, writes as follows: "The physical and chemical properties of oils as now determined, bear a certain relationship to one another, when considering specific gravity or density, boiling range, flash-point, fire-point, capillarity and viscosity. Either determination taken alone, for instance, drawing conclusions from the use of an oil of a certain specific gravity, is valueless, for it is quite feasible to mix light and heavy oils thereby obtaining oils of any desired specific gravity. But a low gravity reading combined with a low flash-point and boiling range will give some indication of the volatile constituents of the oil; in a measure indicating the penetrating power of the oil and subsequent injury to foliage."

15. Some report little difference between the so-called red and white oils and a few indicate greater toxicity for the white oils. The majority however consider the red oils slightly more toxic to insects and more harmful to plant tissue than the white oils. The white oils are prohibitive in many cases, however, because of cost. Emulsions prepared with the two types of oils appear to be equally stable.

16. There is a great variety of opinion relative to the merits of different emulsifiers. The soap emulsifiers with heat apparently give a more stable emulsion but on the other hand soap emulsions are more affected by waters upon dilution than are the cold mixed emulsions with Bordeaux, casein, etc. An excess of emulsifier in the cold mixed emulsions may reduce the efficiency. Parker reports a better control of leaf-roller with caseinate-oil emulsion than with soap-oil emulsion.

17. Some report no harmful effect when oil sprays follow a sulphur spray. In the majority of cases, however, severe burning results and recommendations should call attention to this fact.

18 and 19. The adhesiveness of arsenate of lead is greatly increased when applied with an oil spray or when followed by an oil spray. According to Newcomer "Analyses show that practically none of the lead can be removed by ordinary wiping" where oil follows lead sprays and he sends a photograph to illustrate. This is the general observation of most experimentalists and is very important in view of the recommendations calling upon growers to remove excessive amounts of spray residues.

There is some indication that arsenate of lead in combination with oil emulsion causes dropping of fruit and foliage.

20. There is a general belief, based on experimental evidence, that a combination Bordeaux-oil emulsion spray is slightly less efficient as an insecticide than oil alone but that there is no difference in the fungicidal efficiency of the Bordeaux. Porter's experiments indicate that full strength Bordeaux with oil materially reduces the efficiency of the oil when used as a summer spray.

Parrott found the 2 per cent oil emulsion with Bordeaux applied as a delayed dormant, followed by the usual schedule, was just as effective against apple scab as lime-sulphur. Other observers report the combination as effective against peach leaf curl.

Respectfully Submitted,

J. J. DAVIS, *Chairman*
W. W. YOTHERS
A. J. ACKERMAN
L. HASEMAN

Committee

Scientific Notes

The Cotton Worm in Michigan. At the Corn Borer Station, maintained by the U. S. Bureau of Entomology and the Michigan State College at Monroe, Michigan, various truck, garden and field crops were grown the past season. Among these crops was cotton. This grew to over two feet in height, bloomed, fruited some of the bolls, almost reaching maturity. On or about September 15 it was observed that the foliage of these plants was badly damaged by the cotton worms. All stages of the larvae were found including several cocoons. Adults were also noticed flying about. It would seem that migrant moths arrived at Monroe during the latter part of August.

Damage to grapes and peaches was reported from various points in southern Michigan.

This is probably the first time that this insect has completed a generation in Michigan.

PHILIP LUGINBILL, *U. S. Bureau of Entomology,*
Monroe, Michigan.

Archytas cirphis—AN EXPLANATION AND CORRECTION

The October 1926 issue of the JOURNAL contains a paper by O. H. Swezey on "Recent Introductions of Beneficial Insects in Hawaii." On account of the distance, author's corrections of galley proof did not reach the editor in time to be incorporated before going to press. Thus a desirable footnote to *Archytas cirphis* Curran, on page 718 was omitted. This footnote was to call attention that the writer had received the name from Mr. Curran but that so far as was known the description had not been published. By recent letter from Mr. Curran it is now known that it will yet be a few months before the description is published. As printed on page 718, and also on page 715, the name *cirphis* is incorrectly spelled.

Another misspelled word occurs on page 716, line 28, where "*Prosopus*" should be "*Prosopis.*" Further, the line at bottom of page 715 should read: Proc. Haw. Ent. Soc., Vol. V, No. 2, p. 299, 1923. The reference as printed is incomplete.

O. H. S.

Injury to Sweet Potato by *Systena taeniata* var. *blanda* Larva. From observations made during the fall of 1926, it is evident that the larva of *Systena taeniata* var. *blanda* is responsible for a certain type of injury to sweet potatoes in some sections of North and South Carolina. For several years small pin-like holes, and some larger, have been noted in sweet potatoes at the time of harvest. Thorough inspection of the stored crop has not given any indication of the agency responsible for the damage. During September examinations were made of sweet potatoes in the fields at Pantego, N. C., and the larvae of *Systena taeniata* var. *blanda* which reached the adult stage about the middle of October, were found feeding on the potatoes. These field inspections showed that in most cases the larvae fed intermittingly, spending the rest periods in the soil adjacent to the potatoes. This manner of feeding resulted in attack on a new area of potato at each feeding period, which accounts for the volume of surface injury. When the potatoes were disturbed, any larvae in the act of feeding quickly dropped to the ground. The damage consisted for the most part of pin-like holes in the epidermis, with some extending down into the potato to a depth of $\frac{1}{16}$ inch or more. The stem end of the potato was subjected to greater attack than other portions but in some instances the whole potato was injured. The principal

damage occurred during September and early October, the first adults emerging about the second week in the latter month. The damage seemed to be more severe than elsewhere on dark muck lands where sweet potatoes had followed a crop of spring white potatoes. While this type of injury had been observed for several years, it had received little attention from the growers, since it did not affect the food value of the potato or reduce the yield. When the growers began to market their potatoes through cooperative associations, however, a rigid inspection was required and this injury was brought very forcibly to their attention. At Pantego, N. C., when the 1925 crop was marketed, several growers had as much as 10 per cent of their crop discarded because of injury by this flea beetle.

W. A. THOMAS, *Bureau of Entomology.*

Damage to Potato by *Pycnoscelus surinamensis.* During June, 1925 while conducting an anopheline survey in southern Haiti, the French priest at La Valle, a village situated at an altitude of 2400 feet near the city of Jacmel, showed me specimens of a species of roach which was inflicting severe damage upon the tubers of his potato crop. Since material was abundant a number were brought alive to Port au Prince Approximately 40% of these were parasitized by a sarcophagid determined by Dr. Aldrich as *Sarcophaga sternodontis.* Mr. Caudell identified the roach as *Pycnoscelus surinamensis.* Records indicate that heretofore this form has confined its depredations chiefly to roses. WM. A. HOFFMAN

Names of Apple Leaf Hoppers. The writer has recently acquired by exchange with Dr. D. M. DeLong specimens of his *Empoa* (*Typhlocyba*) *malini* described in the JOURNAL OF ECONOMIC ENTOMOLOGY for June 1926 (Vol. 19, No. 3, pp. 469–470). Examination of the internal genitalia of these reveals that the species is the same as the *Typhlocyba xanthippe* described by me in the Proceedings of the U. S. National Museum, Vol. 68, Art. 18, p. 14. Dr. E. P. Felt, editor, has kindly informed me that the issue of the JOURNAL OF ECONOMIC ENTOMOLOGY referred to was published June 15, while my paper was issued June 10, thus having priority. It is possible as pointed out in connection with my description that the species has been named in Europe, although I have not yet been able to verify this surmise.

In the revision of the American *Typhlocyba* I named *T. pomaria*, which evidently is primarily an apple insect, being reported from that plant in Pennsylvania, Virginia, Illinois, Arkansas, and Colorado. It is known to occur also in Nova Scotia, Massachusetts, Maryland, Ontario, Iowa, and Kansas. *Typhlocyba xanthippe* McAtee (*malini* De Long) is known from Massachusetts, New York, and Ohio. *T. rosae* Linnaeus, which in the past has generally been assumed to include all apple-feeding *Typhlocyba*, while primarily a rose feeder, actually breeds on apple also. It appears to occur throughout all but the southeastern states. Various species of *Erythroneura* may be found temporarily on apple but apparently only *E. hartii* Gillette, breeds on this plant. It is known to occur from Connecticut and Virginia to Illinois and Arkansas.

While upon the subject of names of the apple leaf hoppers and congeners I will advert to Mr. E. P. Van Duzee's note in the *Pan-Pacific Entomologist* for July 1926 (pp. 45–46). Mr. Van Duzee here discusses the question of priority of publication as between *Eupteryx*, Curtis and *Typhlocyba*, Germar. This question is chiefly an academic one as the genera named are distinct on the basis of validly selected genotypes. Nothing depends upon their relative priority except the name of the

supergeneric group—tribe, sub-family, or whatever it may be ranked,—and that only under the system followed by the writer and various others, of basing such names on the oldest included genus, a system Mr. Van Duzee does not use.

The synonymizing of *Eupteryx* and *Typhlocyba* as done by Mr. Van Duzee in his Catalogue (1917, p. 707) is quite another matter, and is strictly unlawful under the generally accepted rules of nomenclature. Curtis designated the type (*picta* Fabricius) of his genus when he described it in 1833, and Woodworth in 1889 remarking that all the species originally included in *Typhlocyba* except *quercus* Fabricius belong to *Eupteryx* in its most restricted sense designated that species as the type.[1] Having validly selected and actually generically distinct type species, the two genera can be synonymized by no legal nomenclatorial process. The name *Empoa*, Fitch used by Van Duzee for the apple leaf hoppers is virtually a *nomen nudum* as its type species *E. querci* Fitch is unidentifiable because the original description of that species applies as well to one as another of several species, and the type specimen is lost.

W. L. McATEE

FERNALD ENTOMOLOGICAL CLUB

Massachusetts Agricultural College entomologists attending the Fifth Philadelphia Meeting of the American Association for the Advancement of Science assembled for dinner on New Year's Eve in the Hotel Normandie, Philadelphia. The speaker of the evening was Dr. H. T. Fernald. On the proposal of Dr. W. A. Hooker the old Fernald Entomological Club was reorganized, with Dr. W. E. Hinds as president and Perez Simmons as secretary. The object of the club is the promotion of co-operation and acquaintanceship among the many entomologists who have studied under the guidance of Professor C. H. Fernald and Dr. H. T. Fernald. There are no dues, and all entomologists who have worked under the Fernalds constitute the membership.

Those present at Philadelphia numbered 32, as follows: Dr. H. T. Fernald, Amherst, Mass.; A. J. Ackerman, Bentonville, Ark.; Dr. H. W. Allen, Riverton, N. J.; D. F. Barnes, Melrose Highlands, Mass.; A. I. Bourne, Amherest, Mass.; S. W. Bromley, New York City; A. F. Burgess, Melrose Highlands, Mass.; R. L. Coffin, Riverton, N. J.; S. M. Dohanian, Melrose Highlands, Mass.; C. F. Doucette, Santa Cruz, Calif.; Dr. E. P. Felt, Albany, N. Y.; R. B. Friend, New Haven, Conn.; G. J. Haeussler, Riverton, N. J.; Dr. W. E. Hinds, Baton Rouge, La.; H. E. Hodgkiss, State College, Pa.; Dr. W. A. Hooker, Washington, D. C.; J. A. Hyslop, Washington, D. C.; B. R. Leach, Riverton, N. J.; G. F. MacLeod, State College, Pa.; L. S. McLaine, Ottawa, Canada; G. B. Merrill, Gainesville, Fla.; Dr. A. W. Morrill, Los Angeles, Calif.; C. M. Packard, W. Lafayette, Ind.; L. H. Patch, Sandusky, O.; H. B. Peirson, Augusta, Maine; Dr. B. A. Porter, Vincennes, Ind.; Dr. W. S. Regan, Yakima, Wash.; E. A. Richmond, Riverton, N. J.; Perez Simmons, Silver Spring, Md.; C. W. Stockwell, Riverton, N. J.; R. D. Whitmarsh, Wooster, O.; and H. N. Worthley, State College, Pa.

[1]Psyche 5, 1899, p. 211. For a full discussion of these matters matters see Proc. Biol. Soc. Wash., 31, 1918, pp. 111-113.

JOURNAL OF ECONOMIC ENTOMOLOGY

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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The Philadelphia gathering will be remembered as one of the large meetings which dealt with matters of pressing importance. The two large and intensely interesting conferences on the European corn borer and arsenical residues demonstrate the possibilities of general conferences, even at meetings with crowded programs. The major interest is bound to dominate and incidentally a side light is thrown on the possibilities of two sections meeting at the same time. We must recognize the passing of the time when all subjects can be covered within a reasonable period in a single series of meetings. It is doubtful if the time of presentation of papers can be limited more than at present unless it is decided to submit all as mimeographed abstracts, grouped as to subjects and discussed under a common head. This would permit presentation of papers and allow discussion of those of sufficient general interest to warrant such treatment. The special paper, while informative and valuable, is better appreciated, as to details at least, when printed and usually can be discussed advantageously by relatively few. The work of the committee on the program is not made easier by the rather usual alternation of large and small meetings, since the varied conditions in the two make difficult the application of an uniform policy.

The necessity of controlling insects and yet marketing fruit above suspicion so far as human health is concerned, shows the narrow limits within which the entomologist must work and may develop into systematic, professional control of spray operations. Extreme injury by codling moth in a New Jersey area was followed by the organization of a group of fruit growers who, working under close, expert supervision, cleared up a severe infestation and obtained an excellent crop

of marketable fruit. Dr. Headlee is to be congratulated upon his venture into a relatively new phase of economic entomology. It was a real contribution to applied entomology.

Those who attended the instrumental insemination of the honeybee by Dr. Watson were privileged to witness a wonderfully delicate operation, a perfection in technique which is worthy of the highest admiration. It is a noteworthy venture into a hitherto baffiing field and a method which may come to mean much to the beekeepers of the world. A section in which such a demonstration can be staged is a credit to any scientific organization.

Reviews

The Insects of Australia and New Zealand by R. J. TILLYARD, pages i–xvi, 1–560, 44 plates (eight colored), numerous text illustrations. Angus and Robertson, Ltd., Sydney, Australia, 1926.

This is more than an ordinary text book. It is a comprehensive, taxonomic survey of the 45,000 species of insects occurring in a most interesting section of the world for the zoologist or entomologist,—the land of the marsupials, the home of the duckbill and other strange forms. Entomologists of the northern hemisphere will recognize large numbers of the genera and species discussed in the volume and will find many suggestive of entirely different times, a fauna harking back to the days when the world was relatively somewhat younger. The student of distribution will discover much suggestive in this work and its comparisons with the world fauna and that of Australia and the much more restricted one of New Zealand. The numerous citations afford ready access to many sources of original information in regard to these and other topics.

The author has made a special and highly commendable effort to systematize the enormous amount of data assembled in a relatively small compass. Twenty-four orders are recognized and superfamilies used where they can be employed advantageously in bringing generally related forms in one group. There is also a uniform nomenclature of wing veins and comparisons with other generally used systems. The discussion of the fossil insects of the antipodes is an admirable and somewhat unusual feature in a text book. There are illuminating numerical comparisons of the faunae of Australia and New Zealand for the various groups as well as for the class as a whole.

The bulk of the work is taken with the systematic accounts of orders and families, the former being separated by a general tabular statement and the latter by data in the more usual key form, there being in each group a statement in relation to its economic importance. Much of this matter is in small type, presumably to provide maximum information in a minimum of pages. There is a chapter on the collection and preservation of insects, a glossary and an extended index. The illustrations are mostly excellent and an important part of the volume.

A book such as this is the work of years with a background of extensive experience. The author has enjoyed exceptional advantages in both regards and has prepared a

noteworthy contribution destined to hold an important place in current literature. It is the text book of Australia, a storehouse of information for the naturalist and a work which should be available to all general entomologists and naturalists throughout the world. Quarantine officials at important ports in both hemispheres should have a copy of this book at hand. Both author and publishers are to be congratulated upon this addition to general scientific literature.

E. P. FELT

Current Notes

Professor Arthur I. Bourne of Amherst, Mass., addressed the Connecticut Pomological Society at Hartford, December 16.

Mr. George Lewis, British coleopterist, who visited China, Japan, Ceylon, and Algiers, died September 5, aged 87 years.

Professor C. P. Gillette, Director of the Colorado Agricultural Experiment Station, visited the division of insects, U. S. National Museum, November 18.

The public address of the Entomological Society of America was given on Tuesday evening, December 28, by Dr. G. H. F. Nuttall on "Insect Parasites of Man."

According to *Science*, Professor Carlos E. Porter has been elected president of the new Chilean Society of Natural History recently organized at Santiago, Chile.

Messrs. George A. Dean, Manhattan, Kansas, W. P. Flint, Urbana, Ill., J. J. Davis, Lafayette, Ind., and J. S. Houser, Wooster, Ohio, visited Washington, D. C., after the Philadelphia meetings.

The following recent appointments have been made in the Bureau of Entomology: C. H. Griffith, Junior Entomologist, Twin Falls, Idaho; Donald S. La Croix, Junior Entomologist, corn borer work, Sandusky, Ohio.

Dr. Alvah Peterson, of the United States Bureau of Entomology, visited the laboratory at Vineland, Ontario, on October 19, in connection with the Oriental peach moth situation.

Mr. R. M. White, Junior Entomologist, Entomological Branch, completed his appointment on November 15 and intends to take further postgraduate work in entomology at the University of Minnesota.

Dr. Edith M. Patch, Orono, Maine, visited Washington, D. C., after the Philadelphia meetings, and on returning home about the middle of January, she stopped at Riverton, N. J., and New Haven, Conn.

Mr. C. H. Alden, Assistant Entomologist at the Peach Insect Laboratory of the Bureau of Entomology, Fort Valley, Ga., for more than five years, has resigned to enter commercial work.

Dr. Ralph L. Parker of the Kansas Agricultural College, has been promoted to Associate Professor of Entomology, instead of "Assistant Professor" as was announced in the December issue of this JOURNAL.

The twelfth annual meeting of the Pacific Slope Branch, American Association of Economic Entomologists, will be held in conjunction with the meetings of the Pacific Division, A. A. A. S., at the University of Nevada, Reno, Nevada, June 22 to 25, 1927.

Mr. R. D. Bird, Seasonal Junior Entomologist, Entomological Branch, who resigned on September 15, has proceeded to the University of Illinois, where he is employed as an assistant in the Department of Zoology.

A new Japanese beetle quarantine office was recently opened at 42 West First Street, Mount Vernon, N. Y. This office supervises matters relating to the recent extension of the regulated area in New York and Connecticut.

In connection with a trip to New York on annual leave, Dr. William Schaus took occasion to examine the types of Lepidoptera described by Henry Edwards which are housed in the American Museum of Natural History.

Dr. William M. Mann, formerly of the Bureau of Entomology and now Director of the National Zoological Park, was married October 30, 1926, to Miss Lucile H. Quarry, formerly Assistant Editor in the Editorial Office of the Bureau.

Recent announcements have been made of the deaths of the following entomologists: Fernand Meunier, member of the Entomological Society of France; Rev. F. D. Morice, Hymenopterist, England; Tasushi Nawa, Japan; Professor E. Giglio-Tos, University of Turin, Italy.

Dr. L. O. Howard, Chief of the Bureau of Entomology, has been elected an honorary member of the Czechoslovak Academy of Agriculture, for eminence in science as applied to agriculture. The Academy confers honorary membership on only 20 foreigners.

At the meeting of the Nova Scotia Fruit Growers' Association, held early in December, Mr. Arthur Kelsall presented two papers, one entitled "Recent Experiments in the Control of Budmoths," and the other, "Miscellaneous Notes on Some Insects and Insecticides."

Mr. H. C. Fall of Tyngsboro, Mass., arrived in Washington October 22 and spent several days there, studying the types of the Staphylinid genera *Hymenorus* and *Euaesthetus* in the Casey and the Hubbard and Schwarz collections at the U. S. National Museum.

Prof. H. T. Fernald of the Massachusetts Agricultural College has been granted leave of absence from Christmas, 1926, to May, 1927. During this period his address will be 137 East Concord Ave., Orlando, Florida.

Importations of European corn borer parasites for this winter are well under way. More than 45,000 cocoons of *Microgaster tibialis* Nees have been collected in northern France, and some 84,000 borers are on hand from which four species of parasites may be reared.

According to *Science*, a program of radio talks has been arranged by the Boston Society of Natural History, to be given on alternate Wednesdays at 7.30 P. M. from WBZ. The talk for January 12 is by C. W. Johnson on "Some Common Insects of the Household."

Dr. W. H. Brittain, formerly provincial entomologist of Nova Scotia, who has recently returned from a trip around the world as a representative of the American Cyanamid Company, has been appointed Professor of Entomology at MacDonald College, succeeding Professor W. H. Lochhead, resigned.

Mrs. Annie Trumbull Slosson, for nearly 35 years a member of the New York Entomological Society, a collector of insects and author of many articles about insects, and of books and essays on other subjects, died at her home in New York City, October 4, 1926, aged 88 years.

The following officers of the Entomological Society of America were elected at the Philadelphia meeting: President, F. E. Lutz, American Museum of Natural History, New York; First Vice-President, W. E. Hinds, Louisiana State University, Baton Rouge, La.; Second Vice-President, E. P. Van Duzee, University of California, Berkeley, Calif.; Secretary-Treasurer, J. J. Davis, Purdue University, Lafayette, Ind.

Dr. H. Prell, Professor of Forest Entomology at the School of Forestry, Tharandt, Saxony, recently made a visit to the United States and Canada and gave particular attention to the work being done on forest insects in the Bureau of Entomology and the Entomological Branch. He also visited a number of museums and field stations.

Resignations in the Entomological Branch, Canadian Department of Agriculture, have been announced as follows: R. B. McCormack, Fredericton, N. B.; R. D. Bird, Treesbank, Man.; Messrs. R. M. White, E. McMillan and J. E. Revell have completed the periods of their tempor[illegible]poin[illegible]ments. The temporary appointments of G. H. Hammond, A. A. Wood, S[illegible]war[illegible]gy, N. J. Atkinson and W. G. Mathers have been extended.

Mr. Curtis G. Lloyd, founder of the Lloyd Library, Cincinnati, Ohio, died November 11, aged 68. The Lloyd Library contains more than 52,000 volumes and is composed chiefly of works on botany, mycology and materia medica, though including many publications on insects. The series of bulletins issued by the Library contains 27 numbers, of which five are entomological.

Prof. J. J. Davis, of Purdue University, has recently forwarded to the U. S. National Museum the type of *Agrilus paramasculinus* Champlain and Knull. In sending this type, Professor Davis says in part: "Since I believe that the National Museum is the logical place for types, I am sending this specimen to be deposited in the National Collection."

Mr. Arthur Gibson, Dominion Entomologist, attended the International Corn Borer Organization meetings held at Washington, D. C., on November 17 and 18. While in Washington, Mr. Gibson took the opportunity of visiting the various divisions of the Bureau of Entomology, where he was able to discuss many problems of international interest, and to promote further cooperative work between the two services.

Transfers in the Bureau of Entomology have been announced as follows: H. E. Wallace, Miscellaneous Insect Investigations, to Cotton Flea Hopper; R. W. Moreland, G. L. Smith and G. L. Garrison, Tallulah, La. to Tucson, Ariz.; W. A. Baker, Dallas, Texas, to Arlington, Mass.; R. A. Blanchard, Webster Groves, Mo., to Monroe, Mich.; E. W. Davis, Toppenish, Wash., to Twin Falls, Idaho; L. W. Brannon, Birmingham, Ala., temporarily to Federal Horticultural Board.

The Division of Insects, U. S. National Museum, has recently received a valuable lot of Porto Rican Coleoptera from George N. Wolcott. The lot included cotypes of five species described by Dr. Guy Marshall of the British Museum. In transmitting this material, Mr. Wolcott expressed the belief that the types of species should be placed in the National Collection, where they will be available to a large number of workers.

Professor Addison E. Verrill, Professor Emeritus of Zoology in Yale University, died at Santa Barbara, California, December 10, aged 87 years. Professor Verrill was a student and assistant of Agassiz and was actively connected with Yale University for 46 years. He was an authority on deep-sea fauna, and for several years carried on scientific studies in the Bermuda Islands, from which he described many species of insects.

On October 21 a large delegation of farmers, county agricultural advisers, and officials of the Michigan State College, inspected the corn-borer work in progress at the Monroe, Michigan, laboratory of the Bureau of Entomology. Special groups from various counties in the State visited the laboratory in September and October. Dr. Luginbill, in charge, has given a number of lectures on the corn borer to high schools in southeastern Michigan and to the Lenawee County Grange.

Mr. Carl Heinrich of the U. S. National Museum left on Thanksgiving Day for Boston where he will work in the Gipsy Moth Laboratory at Melrose Highlands, Mass., classifying and naming the Lepidoptera which have been reared there. Species which cannot be identified without the use of the collections will be taken to the Museum for more detailed study. Mr. Heinrich will also stop in New York City to examine types in the American Museum of Natural History.

Mr. W. A. Ross of the Vineland Laboratory, Entomological Branch, sailed from New York on December 4 for Scotland, on the S. S. *Cedric*, to spend the Christmas season with his people at Edinburgh. On November 26, Mr. Ross held a conference at Vineland with the General Manager and three other officials of the Canadian Canners, to discuss the Oriental peach moth situation in the Niagara district and to arrange for certain measures to retard the spread of this destructive insect.

Mr. C. R. Cleveland has resigned from the Purdue Agricultural Experiment Station, Department of Entomology, to accept the position of Entomologist for the Standard Oil Co. of Indiana, with headquarters at 910 S. Michigan Ave., Chicago, Illinois. He is to develop the field of use for oil sprays of various kinds, direct the introduction of such sprays in the field and supervise investigations looking toward the development of new oil spray products and the uses of such materials.

On October 29, Mr. R. A. St. George of the Bureau of Entomology visited the firm of Carl Stossel & Sons, located at Front Royal, Va., to bring to a close an experiment relative to the submergence of hickory, oak, and ash wood in water, to prevent subsequent attack by *Lyctus* powder-post beetles. By following practices recommended by this Bureau, this firm, which makes mallets, mauls, etc., has in the past three years been able to reduce insect injury caused to green and seasoned stock from its former magnitude of 15 to 90 per cent to only 1 or 2 per cent.

Resignations in the Bureau of Entomology have recently been announced as follows: W. E. Dove, Insects affecting live stock, to pursue graduate studies at Johns Hopkins University; C. H. Alden, peach insects, to enter commercial work;

T. E. Bronson, O. E. Gahm, L. W. Orr and Gerald Horton to continue their studies; F. H. Worsinger, Japanese beetle quarantine, to take charge of a nursery at Holmesburg, Pa. The temporary appointments of M. W. Stone, I. W. Berryhill, V. E. Romney, Roy Melvin and E. R. Bynum have been terminated. Wallace Colman, Columbus, Ohio, Bean Beetle Laboratory, has been granted leave without pay to complete his requirements for the doctorate at the Ohio State University.

According to *Science*, through the interest of Senator James W. Wadsworth, Jr., and the cooperation of Colonel B. D. Foulois, Commanding Officer, Mitchell Field, State Entomologist Dr. E. P. Felt of the New York State Museum has arranged for systematic collection over Long Island and adjacent territory at various altitudes, with a specially devised insect trap attached to the wing of an airplane. Preliminary work has resulted in capturing two specimens at an altitude of three thousand feet, and it is expected that considerable numbers will be found even higher in the air. It is hoped that this investigation may develop facts of importance in controlling pests and explain insect movements in different sections of the world.

Mr. J. C. Evenden, Forest Insect Investigations, Bureau of Entomology, reports that in the past season control operations were instituted against an epidemic of *Dendroctonus monticolae* in the lodgepole pine stand of the Bitterroot and Beaverhead National Forests. This outbreak, which began some four or five years ago, has at the present time reached a tremendous magnitude; on the East Fork of the Bitterroot River hundreds of thousands of lodgepole pine and yellow pine trees are killed each year. Within the past two or three years the insects have crossed the Continental Divide from this area and established themselves in the Beaverhead National Forest, where the infestation, unless checked by artificial control, promises to become as serious as that on the Bitterroot Forest, where entire lodgepole pine forests are being destroyed.

The U. S. National Museum has recently received a very extensive collection of water beetles belonging to the families Dytiscidae and Haliplidae from John D. Sherman, Jr. This collection contains approximately 20,000 specimens and represents about 400 North American species and about 200 additional exotic species. It includes a few of the types of species described by H. C. Fall and a large number of cotypes and paratypes of species described by this worker. In depositing the collection in the National Museum, Mr. Sherman states that it is given to the Museum in loving appreciation and honor of Dr. E. A. Schwarz, who has done so much to encourage his collecting and to assist him in work on Coleoptera. This collection is in many ways the counterpart of both the Roberts collection of these beetles in the American Museum of Natural History and of the Blanchard collection in the Museum of Comparative Zoology, so that all three institutions now have fairly complete collections of the North American species of these beetles.

Correspondents of Dr. T. E. Snyder of the Bureau of Entomology report that the city of Honolulu, Hawaii, has just adopted a revised building code, laying particular stress on suggestions that will prevent damage to buildings by termites. In Honolulu termites annually inflict on buildings damage amounting to about a million dollars. There is every reason to believe that the entire west coast of the United States will adopt a similarly revised building code. In New Orleans, La., 80 per cent of the frame buildings are infested with termites, and it is believed that a revised code will be adopted there. In Pasadena, Calif., 50 per cent of the business buildings are

infested, some of them being in a dangerous condition. Other localities of the Southwest, Central West, and Southeast are similarly affected, and our goal is to have standard codes for these sections of the country. The city of Washington has a large number of buildings which are severely infested, some of them being badly damaged. It is now believed that a modified building code is the most economical and practical method of preventing such damage.

Horticultural Inspection Notes

Mr. George T. French, State Entomologist of Virginia, was recently appointed collaborator of the Federal Horticultural Board.

Mr. Lee A. Strong, Assistant Director of Agriculture of California, was in Washington for a few days early in November to confer with members of the Department of Agriculture on matters pertaining to quarantine work, and on other subjects.

Mr. O. K. Courtney, who has been employed as an inspector by the Federal Horticultural Board since December 1, 1918, recently sent in his resignation, effective December 31, 1926. Mr. Courtney is leaving the service of the Department of Agriculture to go into commercial work.

The Christmas tree quarantine in southern Quebec, along the international border, has been continued this year, Mr. A. K. Gibson being in charge of the work from October to December 13. Approximately 35,000 bundles of Christmas trees, representing a total value of $18,000 to the farmers of the quarantined area, have been exported to the United States under certification.

The State Crop Pest Commission of Virginia has been abolished, and the duties of the commission have been transferred to the Commissioner of Agriculture and Immigration with headquarters at Richmond, Va. This office is under the direction of the State Board of Agriculture. Mr. George T. French has been appointed State Entomologist and Mr. C. R. Willey, Assistant Entomologist.

A meeting of the Section of Plant Quarantine and Inspection was held in Logan Hall of the University of Pennsylvania, Tuesday morning, December 27, in connection with the meeting of the American Association for the Advancement of Science. The meeting was well attended by entomologists and pathologists from all parts of the country. The chairman of the section, Mr. Lee A. Strong, of California, was unable to be present, and Mr. C. H. Hadley was asked to take charge of the meeting.

A meeting was held December 16, 1926, at El Paso, Texas, to discuss the Thurberia weevil and pink bollworm situations. There were present at the meetings Messrs. H. L. Kent, Lee A. Strong, Oscar C. Bartlett, R. E. McDonald and Hull from the states, and George Becker and F. S. Puckett from the Federal Horticultural Board. A new development in the pink bollworm situation has resulted from the finding of this insect at rather widely scattered points in the counties of Cochise and Graham in Arizona. The cotton plants in this section of the state are mostly small, and are located in small irrigated districts which should be rather easily cleaned up judging by the success met with in the eradication of the insect from several points in southeastern Texas and southwestern Louisiana. Thirty inspectors are at work to determine the limits of these infestations.

Notes on Medical Entomology

A new department of medical entomology has been added to the research division of the South African Institute for Medical Research at Johannesburg.

According to *Science*, a painting of Dr. Walter Reed has beeen unveiled at the George Washington University Medical School. Dr. Reed, at the time of his work in connection with the conquering of yellow fever, was a member of the faculty of the George Washington University Medical School.

Dr. R. C. Roark, of the Bureau of Chemistry, returned to Texas about the middle of October to continue cooperative investigations of the chemotropic responses of the screw-worm fly and related insects. The major part of his time while in Texas was spent at the Uvalde laboratory, working with D. C. Parman.

Dr. W. E. Dove, who has been connected with the Bureau's work on insects affecting live stock and was recently assigned to work in Florida, pursuing studies of creeping eruption of man, resigned from the Bureau on October 13 to take up graduate studies at Johns Hopkins University. At the second annual meeting of the American Society of Parasitologists, Dr. Dove and G. F. White of the Bureau of Entomology presented a report on the work they have been doing with creeping eruption, a skin disease of man which is prevalent in Florida and other parts of the South. As a result of experimental work carried out during the summer and fall of 1926, these investigators, working in Florida, proved that the dogs of that section are infested with two species of hook-worms, *Ancylostoma braziliense* and *A. caninum*, and that one of the larval stages of each of these species is capable of invading the skin of man; also that the lesions produced experimentally are very similar to those occurring in natural infestations. Thus it appears that the mystery of this skin affliction, which for many years has been considered due to fly larvae, has been cleared up.

Apicultural Notes

Mr. Jas. I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, during the latter part of January attended beekeepers' meetings in Virginia and Arkansas, as well as the annual meeting of the American Honey Producers' League at New Orleans.

Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, spent a couple of days recently in New York City for the purpose of instructing the Inspection Service, of the Bureau of Agricultural Economics, of that city, in the use of the new honey grading regulations.

Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, spoke before the meeting of the Maryland State Beekeepers' Association on January 5th. He was also on the program of the Beekeepers' Short Course given at Cornell University during the latter part of January.

During the month of December, A. P. Sturtevant, in charge of the Intermountain Bee Culture Field Station, attended the following beekeepers' meetings: Thermopolis,

Wyoming; Billings, Montana; Bozeman, Montana; Boise, Idaho; Salt Lake City, Utah; Grand Junction, Colorado; and Fort Collins, Colorado. Mr. J. E. Eckert, who is also connected with the Intermountain Bee Culture Field Station, attende several of the foregoing meetings.

Recent visitors at the Bee Culture Laboratory of the Bureau of Entomology included Dr. H. Prell, of Germany; Mr. F. B. Meacham, Instructor in Beekeeping at the North Carolina State College of Agriculture; Mr. E. R. Root and Mr. H. H. Root of Medina, Ohio; Mr. A. A. Granovsky, Assistant Entomologist, University of Wisconsin, Madison, Wisconsin; and Miss C. Lucas, of England, who is taking graduate work at Johns Hopkins University.

Pacific Slope Notes

At a meeting of Orange County, California, pepper growers, called to discuss the very serious damage by the pepper weevil, talks were given by J. C. Elmore and R. E. Campbell, of the Alhambra, Calif., laboratory of the Bureau of Entomology.

At the Los Angeles County Truck Crop Growers Institute, held on October 25 and 26, R. E. Campbell discussed truck-crop pests and their control. On October 27, before the Imperial County Truck Growers Association, he talked on lettuce insects, cantaloupe insects, and the pea aphis.

Mr. E. J. Newcomer, in charge of the Yakima, Wash., station of the Bureau of Entomology, states that the codling moth parasite, *Ascogaster carpocapsae*, introduced at Yakima in 1920, continues to thrive and increase. Collections of codling moth larvae from banded trees near Yakima in 1926 yielded 3,800 larvae, of which 855, or about 22.5 per cent, were parasitized. This percentage is higher than has been found before. More than 500 parasitized larvae have been sent to E. P. Venables, Dominion Entomologist at Vernon, B. C., to establish the parasite in the apple-growing regions of British Columbia.

THE ENTOMOLOGICAL SOCIETY OF PENNSYLVANIA

The fourth annual meeting of the Entomological Society of Pennsylvania was held January 18th at Harrisburg, Pa., in conjunction with the State farm products show. Twenty-three entomologists were present from Pennsylvania representing members of the Bureau of Plant Industry, the Federal Bureau of Entomology and the Pennsylvania State College.

The afternoon was devoted to a discussion of the Oriental Fruit Moth problem emphasizing points that needed further investigation and pointing out progress that had been made during the past year. No definite method of control was suggested although recent investigations favor cultivation and the regular P. D. B. treatment. A report of this meeting will be published in the Proceedings of the Horticultural Society of Pennsylvania for 1927.

In the evening the society adjourned for lunch which was followed by an informal gathering and a few short talks. Moving pictures of the Corn borer and the Japanese beetle were shown through the courtesy of the U. S. Bureau of Entomology. Officers for the ensuing year were elected: President, S. W. Frost; Secretary, C. C. Hill.